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ABSTRACT

Through the Bioengineering and Research to Aid the Disabled program of the National Science Foundation, design projects were awarded competitively to 16 universities. Senior engineering students at each of the universities constructed custom devices and software for disabled individuals. This compendium contains a description of each project in nontechnical language, a list of the individuals involved with the project, and a summary of the project's impact on the disabled person's life. A technical description of the design is also presented, along with a photograph of the device and approximate cost. Examples of the approximately 140 devices include: accessible work-holder, multipurpose desk for a quadriplegic engineer, stationary exercise tricycle, pneumatic sewing machine speed control, voice loudness indicator, spring-assisted leg extender, posture alarm system, door closer, self-injurious behavior monitor, foot control for a cassette player, vertical pole walkway, counting trainer, remote computer accessibility, feeding device, and keyboard overlay and software for music therapy. (JDD)

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NATIONAL SCIENCE FOUNDATION
1989
ENGINEERING SENIOR DESIGN PROJECTS TO AID THE DISABLED

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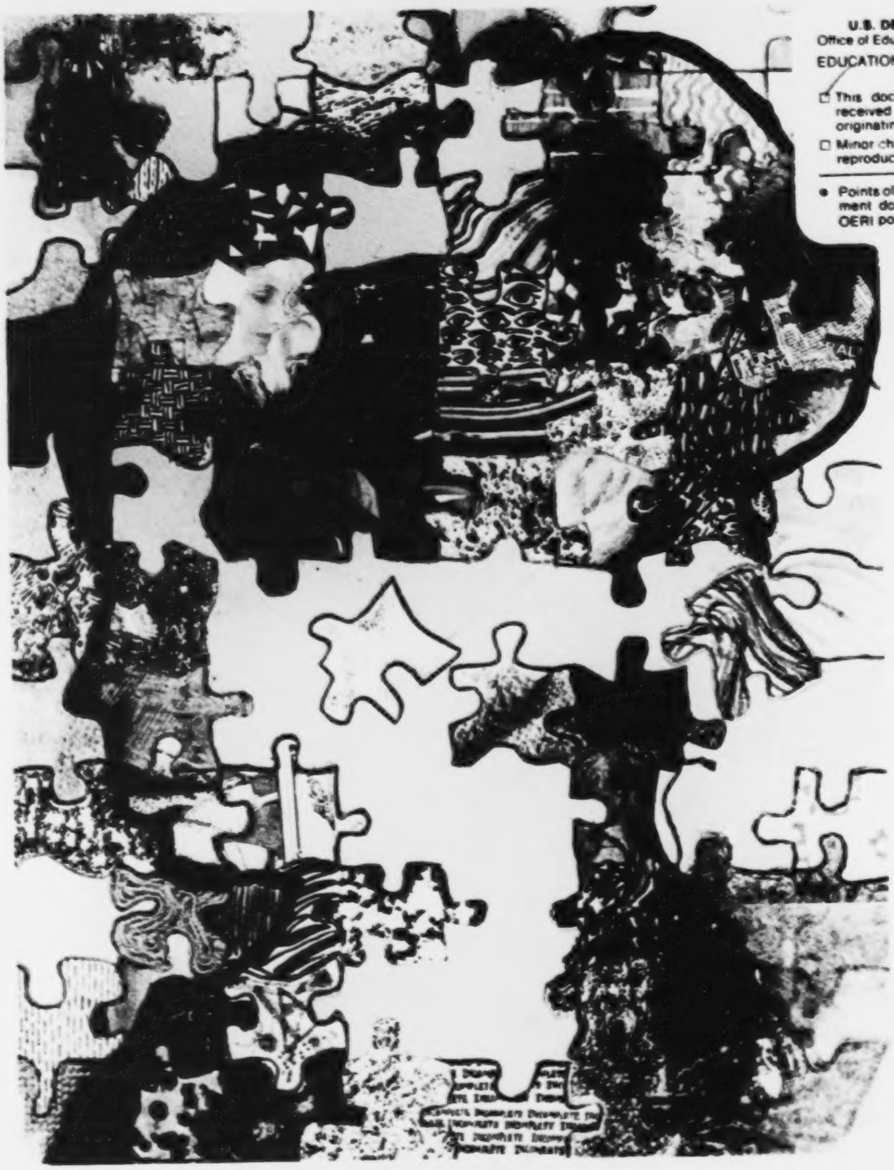

Edited By
John D. Enderle

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1989
ENGINEERING SENIOR DESIGN PROJECTS TO AID THE DISABLED

Edited By
John D. Enderle

NDSU Press, Fargo, North Dakota 58105

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CONTRIBUTING AUTHORS

Robert Allen, Mechanical Engineering, University of Houston, University Park, Houston, TX 77004

Ronald C. Anderson, Biomedical Engineering, School of Engineering, Tulane University, New Orleans, LA 70118

R.J. Conant, Mechanical Engineering, Montana State University, Bozeman, MT 59717

Lester W. Cory, Center for Rehabilitation Engineering, Southeastern Massachusetts University, Dartmouth, MA 02747

Richard A. Dudek, Industrial Engineering, Texas Tech. University, Lubbock, TX 79409

John Enderle, Electrical Engineering, North Dakota State University, Fargo, ND 58105

Richard A. Foulds, Computer & Information Science, University of Delaware, Newark, DE 19716

David G. Gisser, Biomedical Engineering, Rensselaer Polytechnic Institute, Troy, NY 12180

Oliver Hensley, Vice President of Research, Texas Tech. University, P.O. Box 4670, Lubbock, TX 79409

Robert J. Hirko, Engineering Sciences, University of Florida, 231 Aerospace Building, Gainesville, FL 32611

William A. Hyman, Bioengineering Program, Texas A & M University, College Station, TX 77843

Donna Irons, Industrial Engineering, Texas Tech. University, Lubbock, TX 79409

J.L. Katz, Biomedical Engineering, Rensselaer Polytechnic Institute, Troy, NY 12180

Yongmin Kim, Electrical Engineering, University of Washington, Seattle, WA 98195

Daniel J. Krause, Electrical Engineering, North Dakota State University, Fargo, ND 58105

Paul C. Lam, Mechanical Engineering, University of Akron, Akron, OH 44325

Joseph R. Larsen, Rehabilitation Education Services, University of Illinois, 1207 South Oak Street, Urbana, IL 61801

Ton Leamons, Industrial Engineering, Texas Tech. University, Lubbock, TX 79409

Gerald E. Miller, Bioengineering Program, Texas A & M University, 337 Zachry Engineering Center, College Station, TX 77843

Chandler Phillips, Department of Biomedical Engineering, Wright State University, Dayton, OH 45435

David A. Rice, Biomedical Engineering, School of Engineering, Tulane University, New Orleans, LA 70118

Sabrata Saha, Orthopedic Surgery, LSU Medical Center in Shreveport, P.O. Box 33932, Shreveport, LA 71130

Mark G. Strauss, Rehabilitation Education Services, University of Illinois, 1207 South Oak Street, Urbana, IL 61801

Michael K. Wells, Mechanical Engineering, Montana State University, Bozeman, MT 59717

Raymond A. Willem, Mechanical Engineering, New Mexico State University, Las Cruces, NM 88003

FOREWORD

In 1988, the National Science Foundation (NSF) began a program to provide funds for student engineers at universities throughout the United States to construct custom designed devices and software for disabled individuals. Through the Bioengineering and Research to Aid the Disabled (BRAD) program of the Emerging Engineering Technologies Division of NSF[1], funds were awarded competitively to sixteen universities to cover supplies, equipment and fabrication costs for the design projects. This manuscript, funded by the NSF, describes and documents the NSF supported senior design projects.

The purpose of this manuscript is to report on the engineering senior design projects developed and implemented through participating schools in the BRAD program. Each chapter describes the activity at a single university, and except for the introduction, were written by the principal investigator(s) at that university. These chapter reports have not been reviewed or amended by the editor. Individuals wishing more information on a particular design should contact the designated supervising principal investigator. Additionally, an index is provided so that projects may be easily identified by topic.

It is hoped that this manuscript will enhance the overall quality of future senior design projects directed towards the disabled by providing examples of previous projects, and by motivating other universities to participate because of the potential benefits to the student, school, and community. Moreover, the new technologies used in these projects will provide examples in a broad range of applications for new engineers. The ultimate goal of both this publication and all of the projects that were built under this initiative is to assist disabled individuals in reaching towards their maximum potential for enjoyable and productive living.

It should be evident from reviewing this manuscript that the BRAD program has brought together individuals with widely varied backgrounds. Through the richness of these interests, a wide variety of projects were completed, and are in use. A number of different technologies were incorporated in the design projects, so as to maximize the impact of the device on the individual.

A two page project description format is used in this text. Each project is described with a nontechnical description, followed by a summary of impact which illustrates the effect of the project on the disabled person's life. A technical description of the design is presented on the second page of the project description. Photographs of the devices and other important components are incorporated throughout the manuscript.

It should be noted that none of the students or faculty received financial remuneration for building devices or writing software for the disabled in this program. Each of the participating universities has made a commitment to the program for a minimal five year period. A yearly review publication is planned, and it is anticipated that additional universities will choose to participate in the future, so that an even greater impact on the lives of the disabled may be achieved.

Sincere thanks are extended to Dr. Allen Zelman, Program Director of the BRAD program, for being the prime mover behind this initiative, and Dr. Frank Huband, Division Director for Emerging Engineering Technologies. Also, I wish to acknowledge and thank Ms. Shari Valenta for the cover illustration and the illustrations at the end of each chapter, drawn from her observations at the Children's Hospital Accessibility Resource Center in Denver Colorado. I wish to also acknowledge and thank Ms. Rita Prunty for the administrative support assistance she provided during the preparation of this publication.

The information in this publication is not restricted in any way. Individuals are encouraged to use the project descriptions in the design of future design projects for the disabled. The NSF and the editor makes no representations or warranties of any kind with respect to these senior design projects, and specifically disclaims any liability for any incidental or consequential damages arising from the use of this publication.

The projects presented here have been implemented in the first year of this initiative; they have a wide range of depth and usefulness. Faculty members using the book as a guide thus should exercise good judgement when advising students. It is anticipated that the projects will become more analytical and advanced as the program matures, but they will retain the same motivation to help the disabled.

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[1] In March of 1989 the Directorate for Engineering (ENG) was restructured. This program is now in the Division of Biological and Critical Systems.

For more information on this program contact Dr. Peter G. Katona, Program Director, Biomedical Engineering and Aiding the Disabled, National Science Foundation, Washington, D.C. 20550; telephone number: (202) 357-7955.

It is hoped that this book serves as a catalyst and a source of information for future design work. The editor welcomes any suggestions as to how this review may be made more useful for subsequent yearly issues.

John D. Enderle, Editor
Division of Bioengineering
Department of Electrical & Electronics Engineering
North Dakota State University
Fargo, North Dakota 58105
(701) 237-7689

NATIONAL SCIENCE FOUNDATION
1989
ENGINEERING SENIOR DESIGN PROJECTS TO AID THE DISABLED

CHAPTER 1
INTRODUCTION

Devices and software to aid persons with disabilities often need custom modification, are prohibitively expensive, or nonexistent. Much of the disabled community does not have access to custom modification of available devices and other benefits of current technology. Moreover, when available, engineering and support salaries make the cost of any custom modifications beyond the reach of the disabled.

In 1988, the National Science Foundation (NSF) provided a mechanism, through the Bioengineering and Research to Aid the Disabled (BRAD) program of the Emerging Engineering Technologies Division of NSF, whereby student engineers at universities throughout the United States designed and built devices for persons with disabilities. This NSF program enhanced the educational opportunities for students and improved the quality of life for disabled individuals. Students and university faculty provided, through their normal ABET accredited senior design class, engineering time to design and build the device or software, and the NSF provided funds, competitively awarded to sixteen universities, for supplies, equipment and fabrication costs for the design project.

As part of the accreditation process for university engineering programs, students are required to complete a minimum number of design credits in their course of study, typically at the senior level. Design is a course which brings together concepts and principles learned in other courses. In the past, students were typically involved in design projects that enabled the student to improve the quality of their life, for instance, by designing and constructing a stereo receiver. Under this new BRAD program, engineering students at the universities participating in this initiative are involved with designs which result in an original device or a custom modification of a device which improves the quality of life for a person with disabilities. The engineering design students are provided an opportunity for practical and creative problem solving in order to address a well defined need, and the handicapped individual receives the product of that process. There is no financial cost incurred by disabled persons participating in the BRAD program and upon completion, the finished project becomes the property of the individual for which it was designed.

Under faculty supervision, students developed specific projects through their senior design classes in order to address the identified needs of particular disabled individuals. Local school districts and hospitals participated in the effort by referring interested individuals to the program. Each project is specifically designed for a disabled individual or a group of disabled individuals with a similar need by a single student or a team of students.

The emphasis of the program is to: (1) provide disabled children and adults, student engineered devices or software to improve their quality of life and provide greater self-sufficient capability, (2) enhance the education of student engineers by designing and building a device or software which meets a real need, and (3) allow the university an opportunity for unique service to the local community. Some of the projects described here are custom modifications of existing devices, modifications that would be prohibitively expensive to the disabled individual were it not for the student engineer and the BRAD program. Other projects are unique one-of-a kind devices wholly designed and constructed by the student for the disabled individual. The students engineers participating in this project have been singularly rewarded through their activity with the disabled, and justly have experienced a unique sense of purpose and pride in their accomplishment.

After the introduction, seventeen chapters[2] follow, with each chapter devoted to one participating school. The chapters begin by completely identifying the school and the principal investigator(s). Following the chapter introduction for the school, each senior design project description is written on two pages, using the following format. On page one, the individuals involved with the project are completely identified, including the student(s), the professor(s) who supervised the project, and the many professionals involved in the daily lives and education of the disabled. A brief nontechnical description of the project follows along with a summary of the impact on how the project has improved the quality of life of the disabled person. A photograph of the device or the device modification is also included. On page two, a technical description of the device or device modification is given, with parts specified only if they are of such a special nature that the project could not be fabricated without knowing the exact identity of the part. An approximate cost of the project is provided, excluding personnel costs. Individuals wishing more information on a particular design should contact the designated supervising principal investigator.

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[2] While only sixteen universities participated in this program this year, one university had two separate programs with separate principal investigators. Thus it was decided to create two chapters rather than one chapter for that university.

The purpose of this publication is two-fold. One obvious purpose is to serve as a reference or handbook for future senior design projects. If this goal is achieved, the quality of senior design projects will improve and an even greater project impact will be felt by persons with disabilities. Additionally, students will be exposed to this unique body of applied information on current technology, thus providing an even broader education, especially in the area of rehabilitation design. Secondly, it is hoped that this publication serves to motivate both student and graduate engineers, and others, to work more actively in rehabilitation, leading to an increased technology and knowledge base to effectively address the needs of others.

CHAPTER 2

LOUISIANA STATE UNIVERSITY MEDICAL CENTER
DEPARTMENT OF ORTHOPAEDIC SURGERY
P.O. BOX 33932
SHREVEPORT, LOUISIANA 71130

Principal Investigator:

Subrata Saha (318) 674-6187

Force Sensing Resistor Switch

Designer: Jon Hacker
Disabled Coordinator: Linda Nelson and Paula Huckaby, Caddo School for Exceptional Children
Supervising Professor: Subrata Saha, Ph.D.
Department of Orthopaedic Surgery
Louisiana State University Medical Center
Shreveport, Louisiana 71130

INTRODUCTION

Singles switches are often used by handicapped children to operate communication and educational aids, computers, environmental controls and mobility aids. Severe motor impaired students often have difficulty controling the amount of force that is applied to such a switch. The results is a "wearing down" of the sensitivity of the switch. Other students, however, may not elicit an adequate amount of pressure to activate the switch. This points out the need for a pressure sensing switch which can be adjusted to control the threshold force necessary to activate the switch. In this study we have used a commercially available force sensing resistor (FSR) to build such a switch.

SUMMARY OF IMPACT

Figure 1 shows the first force sensing rsistor switch that was built with a small (15 mm diameter) FSR element. This has been used by a few normal volunteers and will soon be used by several motor impaired students at the Caddo School for Exceptional Children.

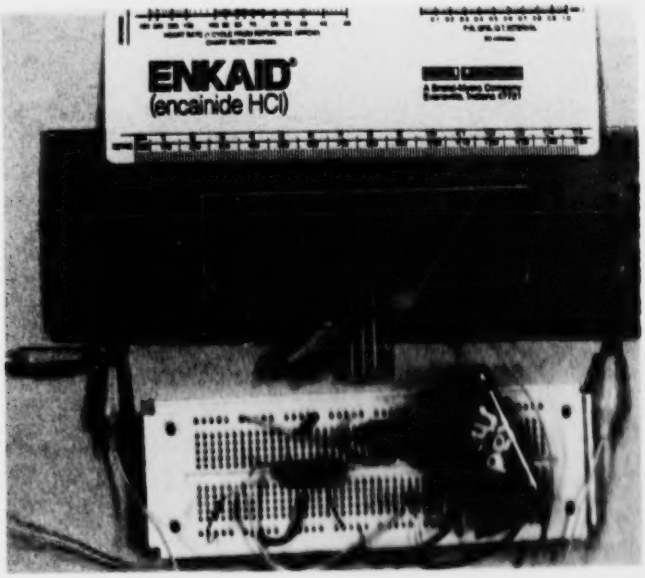


Figure 1: The Force Sensing Resistor Switch.

TECHNICAL DESCRIPTION

The Force Sensing Resistor™ (FSR) is a polymer film device that exhibits a decreasing resistance with increasing force which has been developed for several applications, one being human touch control. Due to the FSR's various characteristics as well as its small thickness (<0.5 mm), these devices made by Intertink Electronics are available in a variety of shapes and sizes. Figure 2 shows the circuit that allows the FSR to be used as a simple force adjustable switch. The comparator circuit allows for the sensitivity of the switch to be adjusted to accommodate the specific needs of the child. This adjustment is done by adjusting the 20 K ohm potentiometer. As force is applied to the surface of the FSR the voltage at pin 9 of the comparator decreases and when the voltage at pin 9 reaches a value equal to or less than the voltage at pin 8, the relay is activated turning the device on. Additional devices (such as a timer device) can be connected or additional circuitry can be included in the device to facilitate added capabilities. The device including the FSR device costs approximately $15.00 per switch; however, the cost will depend on the size and shape of the particular FSR device sed as the active element.

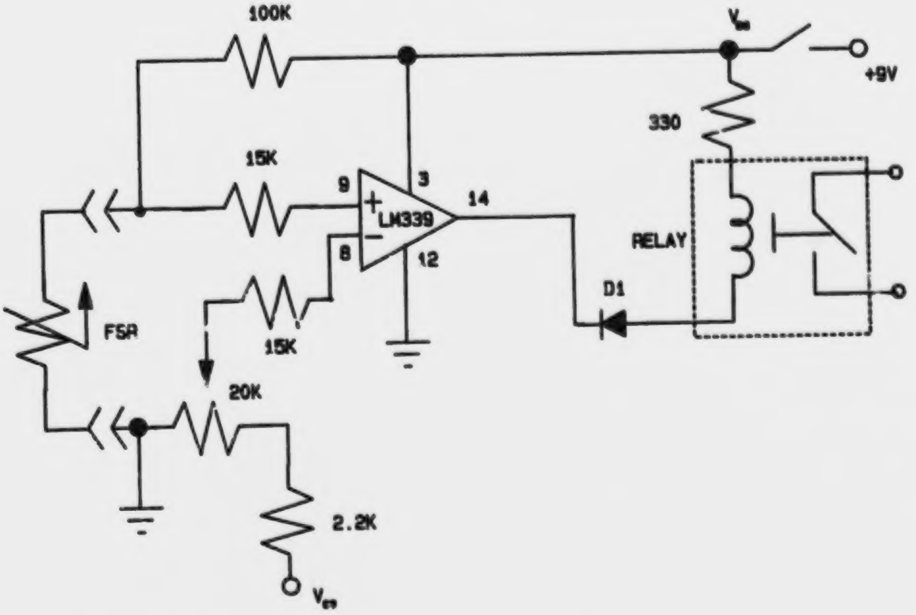


Figure 2. Scematic design of circuit for the FSR switch. The FSR device at left is connected to the circuit and the relay output is connected to the toy or reinforcement.

ACKNOWLEDGEMENT

This work was partially supported by U.S. National Science Foundation Grant EET-8807522.

Visual Scanning Training Device

Designer: Kevin Kline
Disabled Coordinator: Paula Huckaby, Caddo School for Exceptional Children
Supervising Professor: Subrata Saha, Ph.D.
Department of Orthopaedic Surgery
Louisiana State University Medical Center
Shreveport, Louisiana 71130

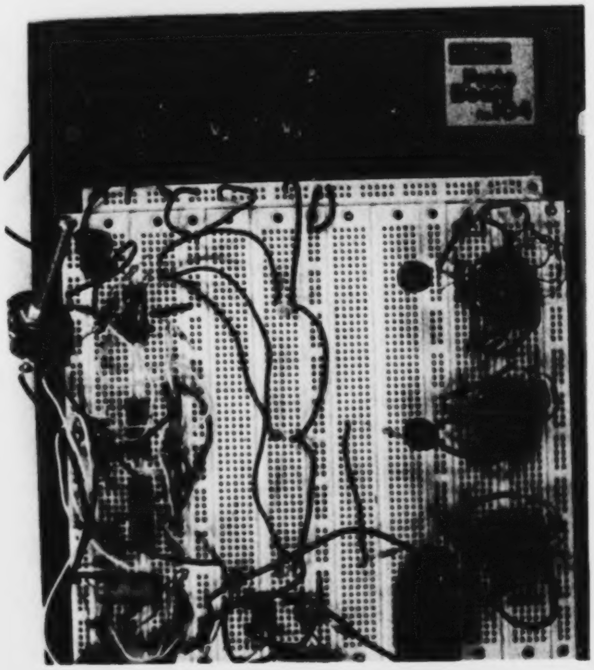
INTRODUCTION

Many electronic assistive devices for handicapped children use LEDs in the scanning mode for feedback action to the children. However, visually impaired students often find it difficult to recognize the LEDs, particulary those of low intensity, depending upon their degree of visual impairment (either perceptive or acquity), appropriate sized LEDs need to be selected for any visual feedback to succeed. In this project, we have attempted to design a visual scanning training device with four sets of different sized LEDs, so that a student using this device can identify a LED of appropriate brightness which he/she can see without any difficulty.

SUMMARY OF IMPACT

This device as not been field tested yet, as the design was modified several times to improve its function and reliability.

Figure 1: The visual scanning training device. The different sized LEDs are shown at the right.



TECHNICAL DESCRIPTION

Figure 2 shows the circuit used for the device. The three D-type flip-flops (SN7474) are configured in a ring-counter arrangement to sequentially cycle the LED display one LED at a time. The cycle is controlled by the clock which is a 555 timer circuit and be changed by adjusting the clock rate. The ring counter produces a logic high on each output channel sequentially which in turn activates one of the LED display elements. The LM324 is a quad-op-amp used to drive the LED display and the 330 ohm resistors are current limiters. The LED display elements can be extra-bright or jumbo size LED's which are available or they can be any of several special types of LED's available commercially. The 500K ohm variable resistor is used to set the reference voltage for the LM324 since the low and high states of the ring-counter outputs are not 0 and 5V, respectively. Although not yet complete, the physical device will be enclosed in a package with a plug-in slot for an LED display plug in module. This allows interchangeable LED displays to be used with the same controlling electronics thereby allowing newer displays to be utilized without rebuidling the circuit also reducing total cost. A connector would permit the display to be ocnnected to the circuit. The total price of one complete unit would be approximately $30.00 to $40.00 with each additional display module costing about $10.00 on up depending on the LED display element and the physical module design needed.

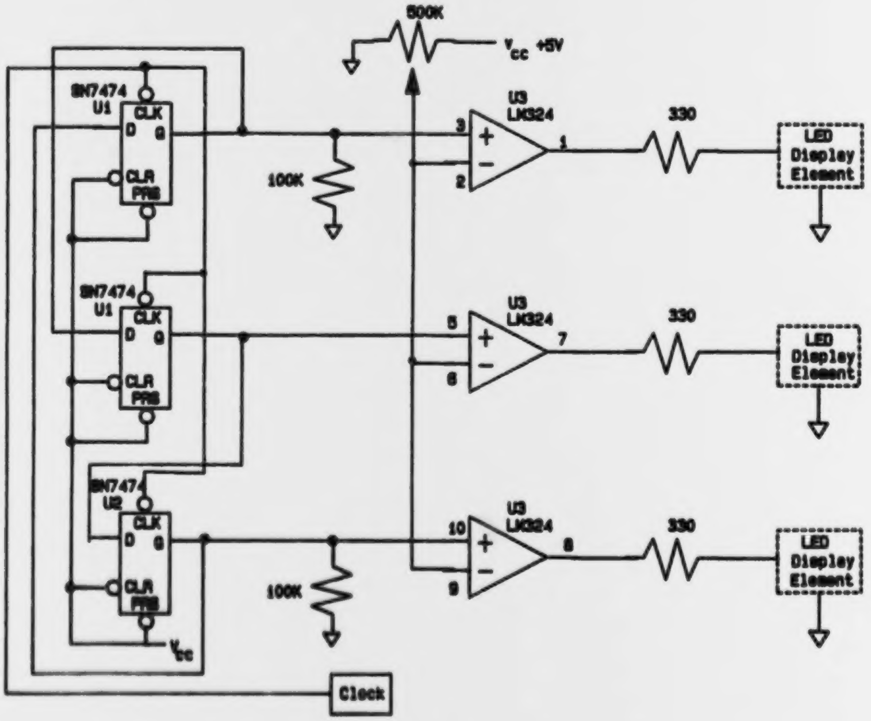

500K
Vcc +5V
SN7474
U1
CLK
D
Q
CLR
PRS
100K
U3
LM324
3
2
1
330
LED Display Element
SN7474
U1
CLK
D
Q
CLR
PRS
U3
LM324
5
6
7
330
LED Display Element
SN7474
U2
CLK
D
Q
CLR
PRS
Vcc
100K
U3
LM324
10
9
8
330
LED Display Element
Clock

Figure 2: Schematic diagram of visual scanning training device. The LED display elements shown at right are connectors allowing for various different types of special LED's to be utilized.

ACKNOWLEDGEMENT

This work was partially supported by U.S. National Science Foundation Grant EET-8807522.

Upper Extremity Training Device

Designer: Trey Rosenthal
Disabled Coordinator: Patricia Hooper, P.T., Caddo School for Exceptional Children
Supervising Professor: Subrata Saha, Ph.D.
Department of Orthopaedic Surgery
Louisiana State University Medical Center
Shreveport, Louisiana 71130

INTRODUCTION

Children with some cogenital deformities (e.g., spina bifida) often have difficulty in the use of their forearm and hand in bearing weight in their attempt to use walkers. Such children need training to improve their capacity to support their body weight by the use of their hand. In this project, we designed a device which provided an auditory feedback to the student as they applied more vertical force with their hand thus reinforcing their capacity to support themselves in the use of a walker.

SUMMARY OF IMPACT

As the device has only been built as a bread-board stage, it has not been field tested yet. However, discussion with the physical therapist indicates that it will be highly beneficial for handicapped children in the training of upper extremity assistive devices. Such training will allow these children to be mobile with the help of walkers and thus be more indepedent.

ENKAID®
(encainide HCl)

TECHNICAL DESCRIPTION

The Force Sensing Resistor (FSR™) made by Interlink Electronics, Inc. is a polymer film device that exhibits a decrease in resistance with increasing force. Figure 2 shows the electrical circuit for the device. The 74C14 is a Schmitt trigger inverter that functions as an oscillator. AS the resistance of the FSR changes (force is applied), the frequency of the output of the inverter increases proportional to the force aplied. The frequency range is determined by R and C. For the the circuit shown the frequency range is 150 Hz to approximately 5.5 Hz. The output of the variable oscillator stage is fed to an audio amplifier (LM 386) which drives an audio transducer that can be mounted on a PC board (Radio Shack cat. no. 273-090). Either a 9V transistor battery or a 9V AC adapter via an input jack can be used to supply power to the circuit. The 7805 voltage regulator provides 5V to the other two stages. The maximum current is about 19ma when a force is applied and 5ma when no force is applied. An output shown in the far right of figure 2 can be sed to connect an external device or additional circuitry to measure the force applied and/or to provide additional reinforcement such as visual or other. When no force is applied, there is no output to the audio amplifier and the amplitude of the audio output can be adjusted by adjusting the variable resistor. The addition of an external device or additional circuitry could increase the current reducing the battery life which may require the 9V AC adaptor to be used instead of making the device dependent on the availability of AC power outlets. The total cost of the device shown in figure 2 is about $25.00.

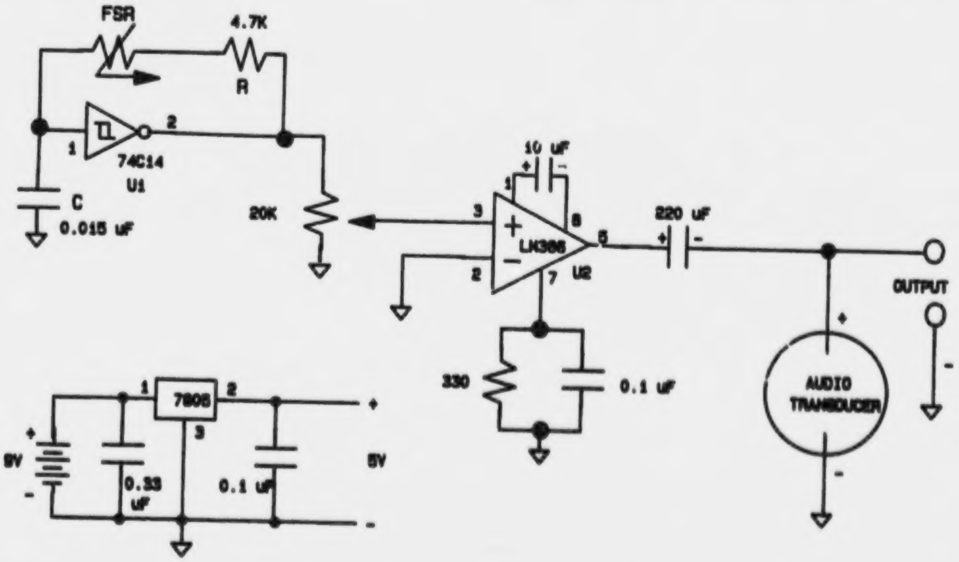


Figure 2: Schematic of the upper extremity training device. It should be noted that there are three stages shown, the power supply, the oscillator, and the audio amplifier. The output at right can be used of additional circuit or external devices for measurements or visual feedback.

ACKNOWLEDGEMENT

This work was partially supported by U.S. National Science Foundation Grant EET-8807522.

Portable Digital Communication and Control System

Designers: Bill Griffis, Jeff Mire, Ching-Yi Chu, Clifford Dunn, and Paul Mire
Supervising Professor: Tom Williams, Ph.D.
Department of Electrical Engineering
College of Engineering
Louisiana Tech University
Ruston, Louisiana 71272

INTRODUCTION

The purpose of this project is to provide a child with limited motor control and no speaking ability the means to communicate with other persons and the means to exercise some control over such activities as turning book pages, eating, turning devies on or off, etc. The project is expected to involve a very small portable computer, a robot arm, voice generation electronics, and support software. It is a multi-year project with the initial concentration of effort being devoted to the portable computer and voice generation modules.

DESCRIPTION

A portable communication is in the process of being designed. This module will be built around a control computer that initially has a single input and outputs that drive a voice synthesizer and a display. The software will be a custom word processor that is stored in permanent memeory so that the system will boot and run independently. The separate hardware items that are required are 1) the computer, 2) the voice synthesizer, 3) the display, and 4) the power supply.

The Computer

The requirements for the computer are low power consumption, single voltage operation, EPROM software support, serial and parallel ports, and programming support. It must also be capable of operation with some type of low power consumption display, preferably a liquid crystal display. A low power consumption (CMOS) PC compatible computer made by AMPRO Computers of Synnyvale, California, meets these requirements and has been selected for use on the project. Power consumption is less than five watts from a single five volt supply.

The Voice Synthesizer

The requirements for the voice synthesizer are 1) compatibility with the computer that was selected, 2) plus five volt operation, 3) low power consumption, 4) high speech quality, and 5) serial port (RS232C) operation.

A search revealed a doll with high quality speech. The doll was manufactured by Worlds of Wonder located in California. We have learned that they were using linear predictive encoding (LPC) chips to synthesize the human voice. These chips have been in widespread commercial sue since the days of the Texas Instruments Speak and Spell toys and are readily available from Texas Instruments.

Another possiblity for the speech synthesizer is a phonetic processor. A speech board of this type is available and it also uses LPC technology but has lower quality speech output than its mathematically modeled counterpart. It offers an unlimited vocabulary (although pronunciation is not always correct) through ASCII text to speech processing. Phonetic speech is also possible with a digital to analog converter.

Digitized speech was the last possiblity investigated. This type of speech has excellnt quality but requires large amounts of memory and high processing speed. The memory requirement ruled this technique out.

Display and Power Supply

A search is underway to locate a suitable liquid crystal display. Several manufacturers have been located but not enough information as been obtained to make a choice. The device should operate off the parallel port in order to simplify programming. More information will be obtained and a decision made as soon as possible.

The Control System

The portion of the system that allows the user to control his/her environment will consist of a robot arm with interchangeable grippers supported by software that will start out at a primitive level and evolve into an expert system that will be capable of carrying out commands without detailed instructions.

ACKNOWLEDGEMENT

This work was partially supported by U.S. National Science Foundation Grant EET-8807522.

Computer Input/Output Interface for Apple II and IIe Computers

Designer: Paul Williams
Disabled Coordinator: Paula Huckaby, Caddo School for Exceptional Children
Supervising Professor: Subrata Saha, Ph.D.
Department of Orthopaedic Surgery
Louisiana State University Medical Center
Shreveport, Louisiana 71130

INTRODUCTION

Caddo School for Exceptional Children has a number of Apple II and IIe computers that they use for various learning tasks. However, there is a large variety of applications that the computers are not utilized for. The Apple computer game input/output (I/O) connector is a 16 pin DIP that provides for various switching inputs and outputs that could be used in a variety of applications dealing with evaluation, training, and instruction. Yet, the limited access of the game I/O connector becomes a difficulty in the realization of the full potential of the device. This can be solved by the proper external interface allowing easy access to the I/O connector. The objective of this project was to design and build such an interface.

SUMMARY OF IMPACT

This input/output (I/O) device has been used successfully at the C.S.E.C. and has been utilized by several students. This device has allowed for software design of applications to meet various needs using the Apple computers without being restricted by I/O hardware access.

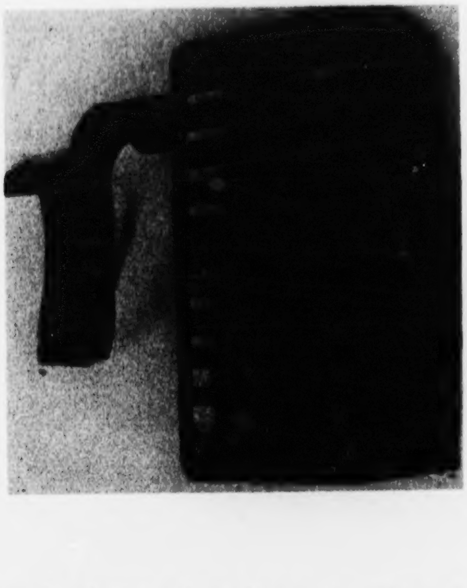


Figure 1. Computer Input/Output Interface for Apple II and IIe Computers

TECHNICAL DESCRIPTION

The Apple computer's game board has a 16 pin DIP connector by which a variety of inputs and outputs can be accessed. As shown in figure 2 the connector has 3 push-button inputs, 4 variable resistor inputs, and 4 annunciator outputs capable of 5 volt operation. Figure 2 diagrams the electrical connections and circuitry from the 16 pin DIP jumper cable for access to all inputs and outputs via 3.5 mm phone jacks. The 1K ohm resistors connected to the push-button inputs (PB) limit the current through the switch and provide a shunt for the input. The annunicator outputs can be used for turning a tape recorder or other device on or off, and the other mode is a 5 volt output. Both modes can be selected by a switch (shown in figure 1) and the annunciator can be turned on or off by use of peek and poke statements accessible within an Apple basic program. The SN74LS240 is an Octal buffer/driver for driving the 5 volt output to the reed relays or to another device. An additional 3.5 mm jack or appropriate connector (not shown in figure 1) allows a 9V AC adapter to be plugged into the device. This connection provides the 5V power supply via a regulator, shown in figure 2. By having all of the input and output capabilities of the game board's I/O connector outside the computer and the capabilities of Apple basic programming specific application software can be designed to aid in various needs of evaluation and training to assist the handicapped. The cost of the device completely assembled in about $50 maximum.

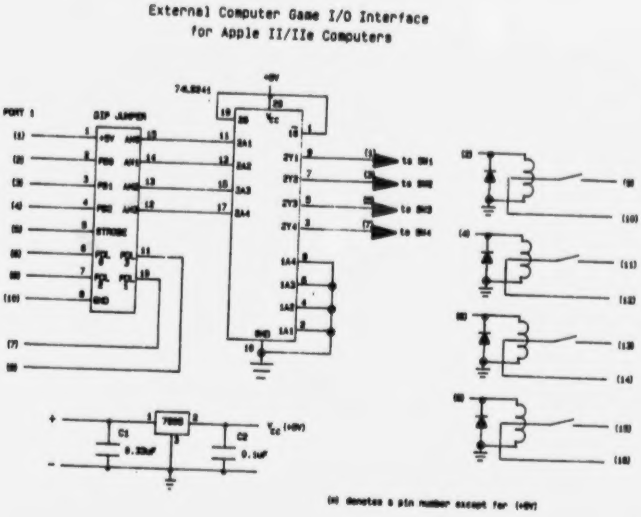

External Computer Game I/O Interface
for Apple II/IIe Computers
+5V
PORT 1
DIP JUMPER
STROBE
GND
Vcc
2A1
2A2
2A3
2A4
2Y1
2Y2
2Y3
2Y4
1A4
1A3
1A2
1A1
to SW1
to SW2
to SW3
to SW4
7805
C1
0.33uF
C2
0.1uF
Vcc (+5V)
(n) denotes a pin number except for (+5V)

Figure 2. Schematic diagram of External Computer I/O interface for the Apple II/IIe game I/O connector.

ACKNOWLEDGEMENT

This work was partially supported by U.S. National Science Foundation Grant EET-8807522.

Knee Brace Alarm

Designers: Winn Johnson and Jon Hacker
Disabled Coordinator: Linda Nelson, Caddo School for Exceptional Children
Supervising Professor: Subrata Saha, Ph.D.
Department of Orthopaedic Surgery
Louisiana State University Medical Center
Shreveport, Louisiana 71130

INTRODUCTION

Diseases that can affect the peripheral nervous sytem such as cerebral palsey may not effect the entire system, yet may only affect the sensory feedback pathways. For children in this situation an appropriate feedback device can assist in proper walking without constant observation by another person. A student at the Caddo School for Exceptional Children has such perceptual problems and he also has very weak muscles. He often does not know where his body is in space; thus when he bends his knee beyond a certain angle, he falls down. A knee flexion alarm device was designed for this student.

This electronic device was built so that when attached to the long leg brace of the student it provided an audio signal when the knees are in excessive flexion when walking.

SUMMARY OF IMPACT

The student has used this device so that whenever he hears a beep from the black box attached to his belt he remembers to straighten his knee. This has allowed this student to be more mobile and independent. The gait of this student also improved as the alarm system helped him to increase knee extension during stance phase and he learned to walk in a more erect fashion.

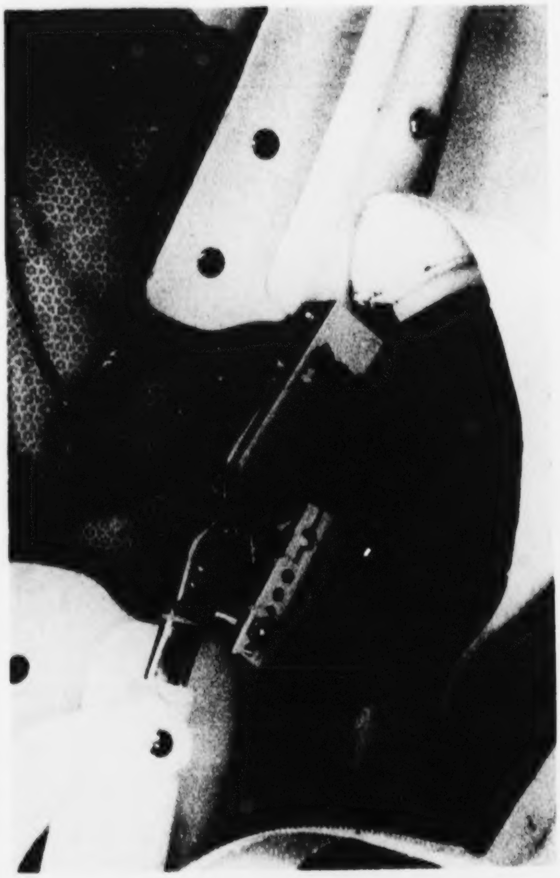


Figure 1. Knee flexion alarm attached to the knee brace.

TECHNICAL DESCRIPTION

The device requires two separate signals of which one is a reference and the other corresponds to the flexion angle of the knee brace. By comparing the two signals the device will signal the child when the proper condition is not present. With a variable reference the angle of flexion at which the device signals the child gradual training can be performed where the child learns at its own rate to maintain the proper knee position. The circuit for such a device is shown in figure 2. The positive input is the reference voltage which can be set by adjustment of the 20 Kohm potentiometer each voltage corresponds to a particular angle. The negative input to the LM339 is connected to the 10 Kohm potentiometer which is mounted to a knee brace that the child wears. This voltage changes with the angle of the knee brace which corresponds to the flexion angle of the child's knee. The 10 Kohm potentiometer is connected so that as the flexion angle of the knee increases so does the voltage. Depending on the setting of the 20 Kohm potentiometer, when the knee is flexed to an angle equal to or greater than necessary the output of the LM339 goes low enough to provide the required voltage across the piezoelectric buzzer to activate the buzzer and the child hears an audible sound signaling that the knee is flexed too much. A switch allows the device to be turned off when needed and an LED with current limiter resistor indicates whether the device is on or off.

The 10 Kohm potentiometer is mounted to the knee brace with the jig shown in figure 1. One part holds the pot and clamps to the upper part of the brace. The other part clamps to the shaft of the pot and is strapped to the lower part of the brace. A cable runs from the pot and terminates in a small box worn on the child's belt that houses the circuitry. A belt clip mounted to the box allows the device to be worn without inconvience or discomfort, yet allowing for easy placement or removal.

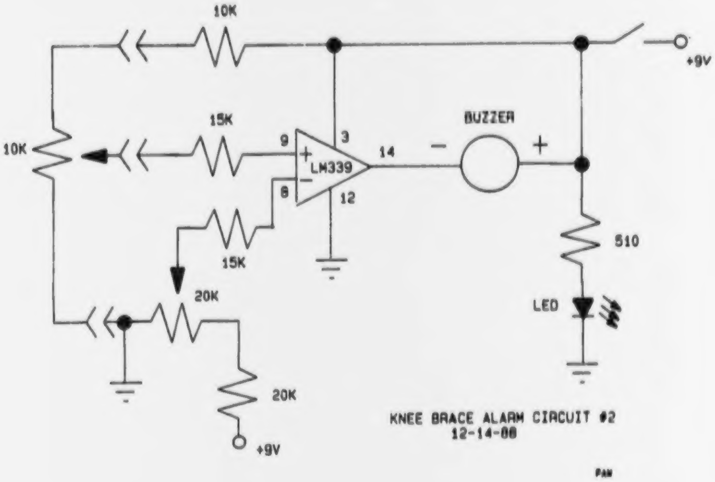


Figure 2. Schematic diagram of knee brace alarm circuit. The 10K Potentiometer at left is mounted on leg brace.

ACKNOWLEDGEMENT

This work was partially supported by U.S. National Science Foundation Grant EET-8807522.

Posture (Tilt) Alarm System

Designer: Paul Williams
Disabled Coordinator: Patricia Hooper, P.T., Caddo School for Exceptional Children
Supervising Professor: Subrata Saha, Ph.D.
Department of Orthopaedic Surgery
Louisiana State University Medical Center
Shreveport, Louisiana 71130

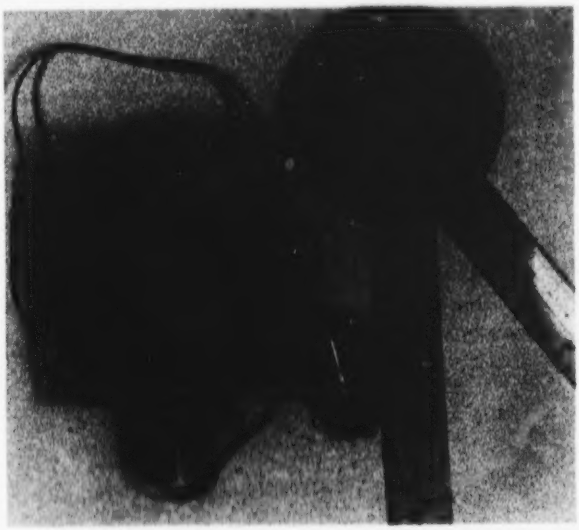
INTRODUCTION

Some children have difficulty in maintaining correct posture due to their tendency of leaning to one side. If this is not controlled, the child may fall. For some children, this requries strapping the child to a vertical support. An external device that would signal the child when he is leaning could aid in the maintaining of correct posture of a child and help the child to perform the task without the aid of another person. Such a device utilizing a mercury bulb as a switch to a buzzer was constructed. The mercury bulb was placed in a sealed tube of plexiglass for protection, and an on/off switch with an on light was included in the circuit. The device allows for other switching devices to be connected by way of a 3.5 mm connector. The mercury bulb is fastened to the child or the child's clothing at an angle so when the child reaches the angle of tilt the alarm buzzer is turned on signaling the child to straighten up.

SUMMARY OF IMPACT

This posture alarm has been used by one student. In the beginning the alarm had the mercury bulb switch only on one side; this prompted the student to overcorrect his tilting to the opposite side. This has been corrected by providing mercury bulbs for both right and left sides so that the student gets a warning signal for excessive flexion to either side.

Figure 1: Posture (Tilt) Alarm System.



TECHNICAL DESCRIPTION

Figure 2 shows the circuit schematic for the posture (Tilt) Alarm system. As shown in figure 1, a mercury switch is enclosed by a plastic tube which is sealed at both ends with silicone glue. Wires conncted to the mercury switch exit through the glue at one end of the plastic tube and connect to the circuit via 3.5 mm connectors. The plastic tube with the mercury switches are fastened either to the child's clothing or can be fastened directly to the child with the proper adhesive tape such as some type of medical tape. The mercury switches are fasted such that when the child leans too far to one side or the other one of the mercury switches is clsoed thereby activating the buzzer. Instead of only one buzzer, two buzzers of different frequencies (pitches) of sound can be used to indicate the direction in which the child is leaning too far. The total cost of this device is $10.00 as shown in figure 2.

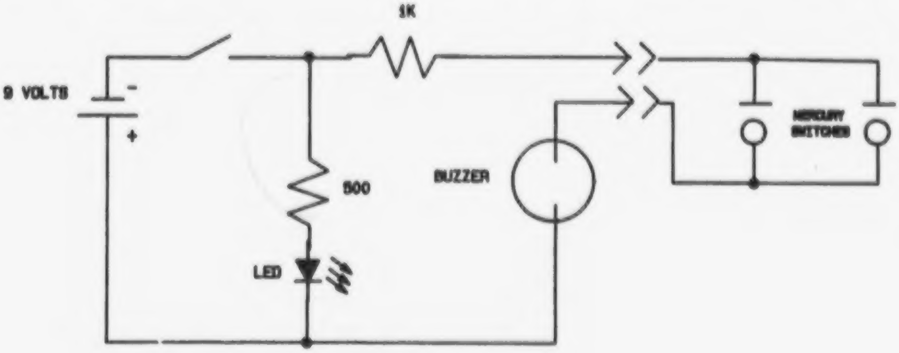


Figure 2: Schematic of posture tilt alarm. The LED indicates the device is on when the power switch is closed.

ACKNOWLEDGEMENT

This work was partially supported by U.S. National Science Foundation Grant EET-8807522.

Timer Switch

Designer: Paul Williams
Disabled Coordinator: Paula Huckaby, Caddo School for Exceptional Children
Supervising Professor: Subrata Saha, Ph.D.
Department of Orthopaedic Surgery
Louisiana State University Medical Center
Shreveport, Louisiana 71130

INTRODUCTION

The importance of toys in the development and learning process is well known to educators who work with physically disabled children. It has been shown by many investigators that through purposeful play a child develops physically, emotionally, cognitively, and socially. Such developmentally appropriate play can often be provided by low cost, battery-operated toys and commercially available games. With modifications, often in the switching unit, the children at C.S.E.C. can benefit from this technique. However, modified battery-operated toys with single switch input requires a child to apply constant contact on the switch to activate the toy. Severe motor impaired students have difficulty maintaining contact on a switch, therefore, disabling them from controlling their environment during play situations. Therefore the objective of this project was to design and build a suitable timer switch.

SUMMARY OF IMPACT

Severe multi-handicapped students now have independence in controlling their battery-operated toys during play situations. It provides the student with an opportunity to be able to activate and enjoy playing with their toys. At the same time it provides the teacher/therapist with an objective measure of the student's ability to understand cause-and-effect relationship.

Figure 1: Timer Switch.

TECHNICAL DESCRIPTION

Figure 2 diagrams the electrical circuit for the timer switch. Any switch with a 3.5 mm connector that the child can utilise is plugged into the input (SWI on the schematic). The circuit takes advantage of a very simple, yet reliable configuration using a 555 integrated circuit device. As the child depresses the switch (SWI), the circuit closes the relay which is connected to a toy or type recorder's remote that will activate the device for a predetermined period of time, then deactivate the device. The 22 Kohm resistor, 1 mega ohm potentiometer, and 45 micro farad capacitor determine the range of time periods that can bet set. By adjusting the potentiometer, specific time period can be set.

The present circuit shown in figure 2 has a time range of about 5 seconds to approximately 50 seconds. The diode between the 555 timer and relay is to protect the timer from back current resulting from the behavior of relays. The completed device costs about $15.00.

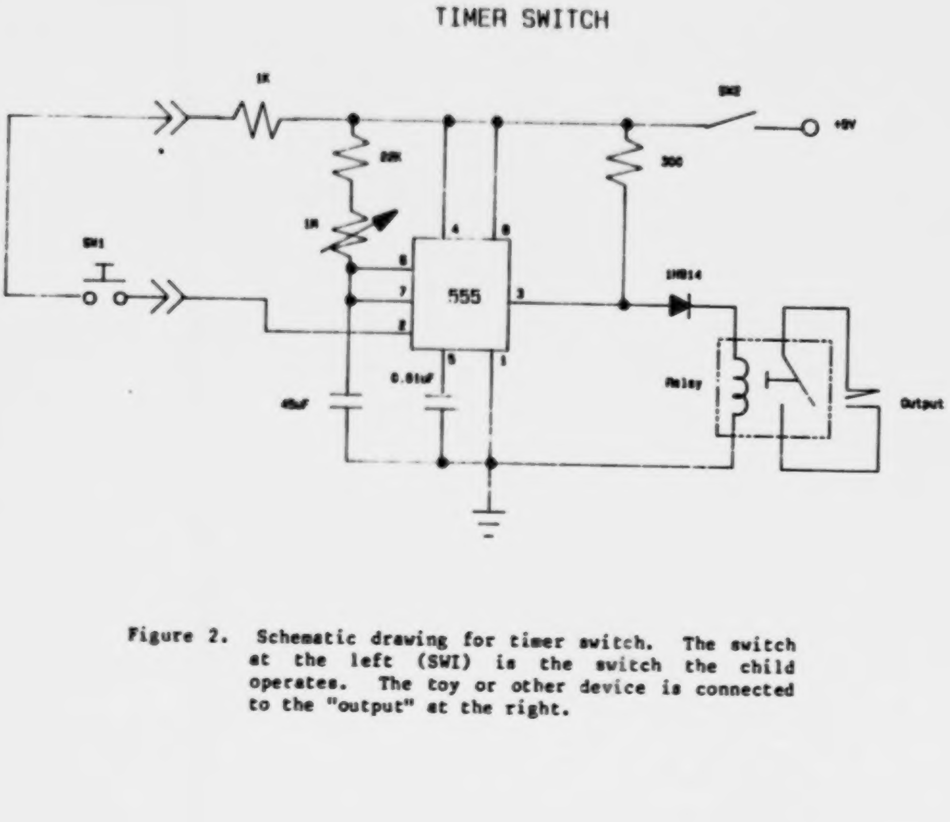


Figure 2. Schematic drawing for timer switch. The switch at the left (SWI) is the switch the child operates. The toy or other device is connected to the "output" at the right.

ACKNOWLEDGEMENT

This work was partially supported by U.S. National Science Foundation Grant EET-8807522.

A DYNAMIC FORCE EVALUATION DEVICE

Designer: Trey Rosenthal
Disabled Coordinator: Laura Reed, Caddo School for Exceptional Children
Supervising Professor: Subrata Saha, Ph.D.
Department of Orthopaedic Surgery
Louisiana State University Medical Center
Shreveport, Louisiana 71130

INTRODUCTION

A variety of communications/learning aids for severely handicapped rely on their ability to operate microswitches to actuate different control devices. As different handicaps involve varying degrees of limitations on the motor skills, the successful use of microswitches by the handicapped is possible only if the most controlled movement of the individual can be used to operate the switch. Thus, to enable use by the handicapped, modification of the standard switches by use of suitable levers, gripping devices and proper placement, etc. is essential. Depending upon the individual abilities/disabilities, these switches can be adapted for operation by moving a hand, a finger, an arm, a foot, or the body trunk. Also, the head, chin or mouth movement can be used to operate the switch. It should be realised that all these adaptations have to be "tailor-made" for each individual depending upon his needs and abilities. We need data on the magnitude and nature of the force that a handicapped student can apply before an appropriate custom made switch can be designed. Presently no such force measurement device is commercially available. Therefore we have designed and built a special dynamic force evaluation unit and this unit has been used to measure the thrust forces and torques that normal and handicapped students can apply with their hand.

SUMMARY OF IMPACT

This unit (Fig. 1) has been used to measure forces and torques applied by fifteen handicapped students. As expected, a wide variation in the magnitude and duration of the exerted forces and torques were recorded. This information will be utilised in the future design of microswitches for these students.

Figure 1: The dynamic force evaluation device. Child is hitting target area on top of load cell.

TECHNICAL DESCRIPTION

A block diagram of the load cell and set up is shown in Figure 2. A Kistler biaxial load cell, Type 9271A, is utilized to measure an axial force in the z direction and a moment about the z axis (as shown in figure 2a). The biaxial load cell is also used so that two measurements may be recorded for each hit. The target area, consisting of a wooden beam clamped to the top of the load cell and two semispherical targest, tennis ball halves filled with a hard resin, proved to be very inexpensive while making directions for the children simplistic. Only forces directed near the very center axis of the load cell provide acceptable measurements, yet an easily identified target area must be utilized, thus the use of the filled tennis ball halves provided appropriate target areas.

To provide positive reinforcement, a capacitor switch is connected to the targets. The switch is then connected to a timer which is in turn connected to a toy. When enough area of the hand covers the tennis ball, the capacitor switch is activated and the toy operates for five to ten seconds. The purpose of the positive reinforcement is obviously to give a reward for the child's effort, to keep the child's interest as long as the experiment is taking place, and to provide time for the researcher to record data. It also can be a determinate or criteria in deciding which hits are valid and which are to be rejected.

Once a force has been applied, a charge representing the force and another the moment are sent form the load cell to the charge amplifiers. The charge amplifier (Kistler, Type 5001) receives the charge and proportionately converts it to a voltage. The particular models used had an output range of 0 to 10 volts. All settings were made according to the manuals provided by the manufacturer (Kistler). The range of the sensitivity could vary form one Newton per volt to five hundred Newtons per volt depending on each child's individual characteristics.

From the charge amplifier, the voltage is directed into a signal analyzer (Data 6000 manufactured by Data Precision). Two channels are monitored and recorded, one being the force and the other the moment. This allows for both force and moment measurements after each hit incurred by a child. The range of both channels is + or - five volts. A remote terminal was connected to the signal analyzer so that tasks such as recording data could be made more efficient, thereby reducing experimentation time. The disk operating hardware is also provided by Data Precision and is used for recording data which may be needed at a later time. Lastly, a plotter (Hewlett-Packard 7470A) is connected to the signal analyzer allowing for hard copies of the waveforms to be made. The cost of the supplies needed for this setup is approximately $25.00 excluding, of course, the load cell (two to three thousand dollars), amplifiers, and data analyzing and recording equipment. It may be noted that any oscilloscope of x-y plotter could be used for data recording and signal analyzing, provided the instrument used has the proper ranges and performance needed.

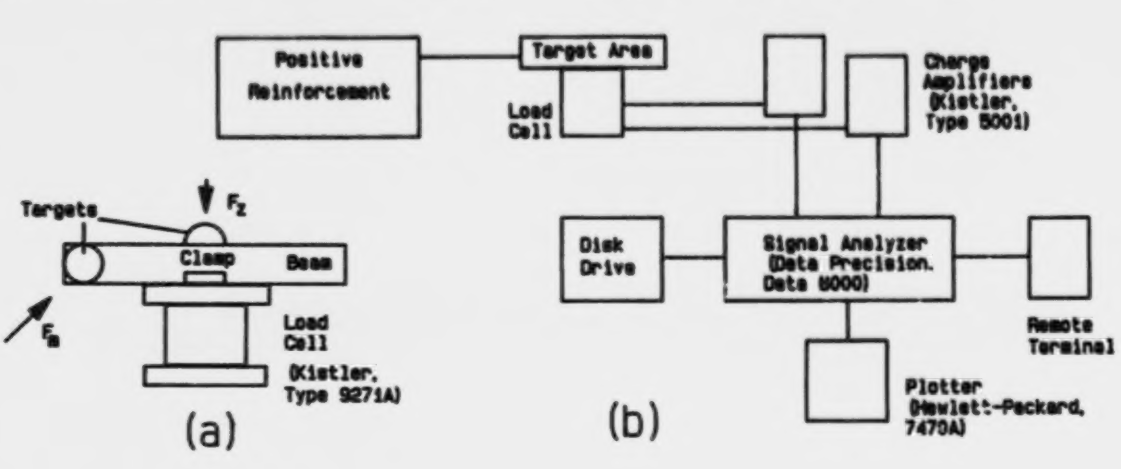

Positive Reinforcement
Target Area
Load Cell
Charge Amplifiers (Kistler, Type 5001)
Targets
F_z
Clamp
Beam
F_a
Load Cell (Kistler, Type 9271A)
Disk Drive
Signal Analyzer (Data Precision, Data 6000)
Remote Terminal
Plotter (Hewlett-Packard, 7470A)
(a)
(b)

Figure 2: a) diagram of load cell and target area,
b) block diagram of signal analyzing and
data recording instrumentation.

ACKNOWLEDGEMENT

This work was partially supported by U.S. National Science Foundation Grant EET-8807522.

A Non-Contacting Capacitive Switch

Designer: Ted Keys
Disabled Coordinator: Paula Huckaby and Linda Nelson, Caddo School for Exceptional Children
Supervising Professor: Subrata Saha, Ph.D.
Department of Orthopaedic Surgery
Louisiana State University Medical Center
Shreveport, Louisiana 71130

INTRODUCTION

During the last decade, microcomputers have become more readily available for use of the disabled population and this has provided a more convenient means of communication and an increased level of independency for them. However, due to severe motor deficiency many children at the Caddo School for Exceptional Children (C.S.E.C.) cannot directly access computers and other electronic augmentative devices. For such students, there is a definite need for an economical, durable switch that a child can operate easily and which can act as an interface between the child and the computer or any other electronic device. In some cases the switch is required to be low force or even zero force activated. Small size and easy handling with little or no risk of damage of injury to the child is also required. A capacitive switch designed and sold for level control (Delta Controls model 104) with minor modifications, has been found to meet these needs.

SUMMARY OF IMPACT

This device has been used by a severely physically disabled student with cerebral palsey. Previously this student communicated through a computer via a microswitch which was activated by her head movement. This switch often needed repair due to constant impact from the head movement. This microswitch was replaced by the non-contacting capacitive switch and it has performed efficiently without any breakdown. Some of the advantages of this device are 1) the probe is connected by cable to the electronics allowing for the activation area to be custom designed and changeable to meet a specific need, 2) the sensitivity of the device is adjustable, and 3) on board delay capability allows for different types of conditions such as minimum time for activation and time-off. There are some features that need to be altered, such as the device is currently AC powered instead of DC battery powered.

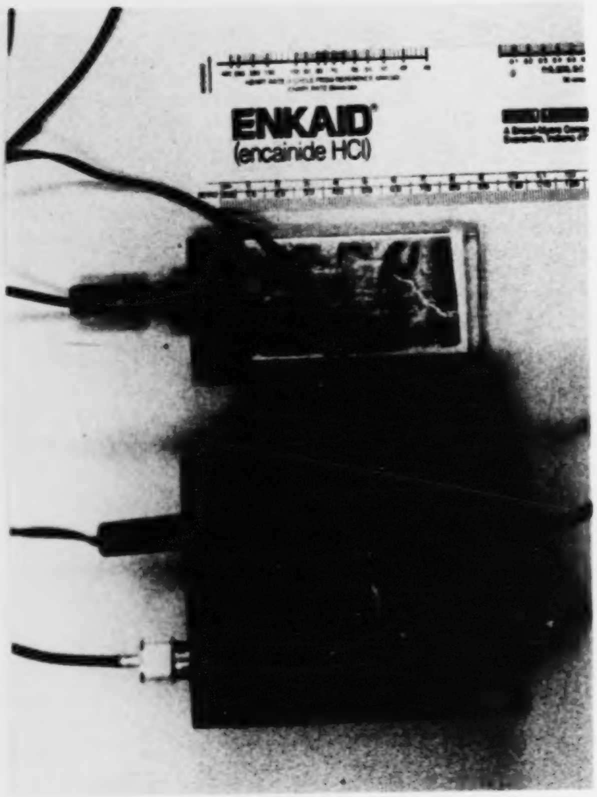


Figure 1: Non-Contacting Capacitive Switch.

TECHNICAL DESCRIPTION

The non-contacting capacitive switch is an adaptation of a circuit used in level control (Delta Controls Corporation, Model 104). Figure 2 illustrates the use of the device where the probe is some type of metal surface (i.e., aluminum, copper) covered with some type of insulative material (such as plastic, plexiglass, or epoxy). The probe can be almost any shape or thickness desired, however, the surface area needs to be as large as is practical. This is because the change in capacitance is dependent on surface area and the distance from the probe necessary for activating the switch. This change in capacitance of the probe is the mechanism by which the switch operates. Using a wire in contact with or connected to the metal surface of the probe a coaxial cable should be used to connect the probe wire to the circuitry via a post located on the circuit board. As shown in figure 1, connectors can be used to allow for different probes to be interchanged. Connectors attached to the circuit board allow for between the device and the toy or other reinforcement to be used. The circuitry (circuit board) costs approximately $100 with the total cost of the device being about $110 on up depending on the probe design. In constructing probes, we have found that aluminum foil and laminating sheets can be used to construct several effective and inexpensive probes.

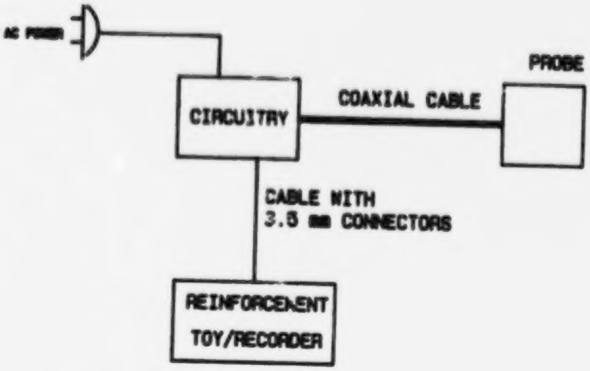


Figure 2. Block diagram of non-contacting capacitive switch with probe and reinforcement which can be any device that can be switched on and off.

ACKNOWLEDGEMENT

This work was partially supported by U.S. National Science Foundation Grant EET-8807522.

Limited Communication Device

Designer: Paul Williams
Disabled Coordinator: Paula Huckaby, Caddo School for Exceptional Children
Supervising Professor: Subrata Saha, Ph.D.
Department of Orthopaedic Surgery
Louisiana State University Medical Center
Shreveport, Louisiana 71130

INTRODUCTION

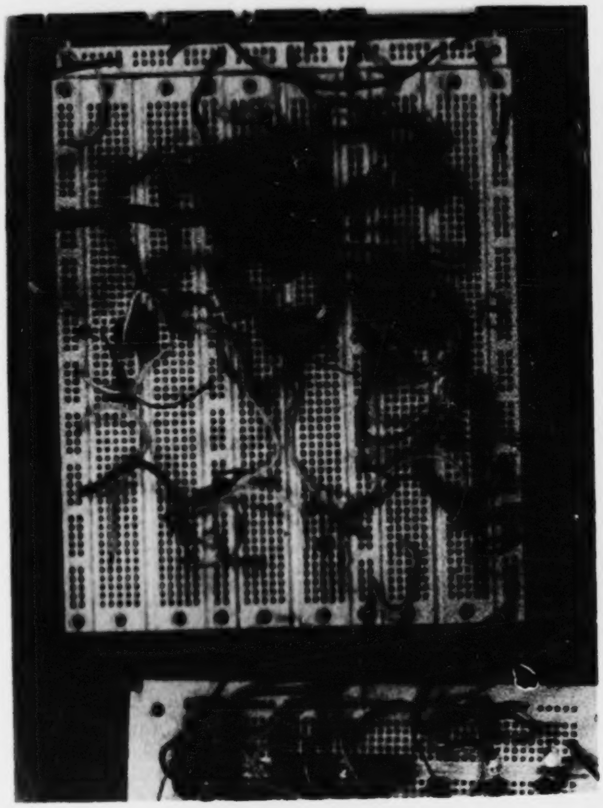
Severe physically handicapped students are limited in the amount of social interaction they can have with their environment. Communication skills of older profound speech-motor impaired students as well as very young severe speech-motor impaired students are limited to eye gazes, unintelligible vocalizations, and gross motor gestures. Devices such as a limited communication device will allow the student to begin training with a tool that adequately matches their cognitive and functional language skills.

The preliminary setup (Fig. 1) contains the use of one to three electronic switches which are individually connected to separate, corresponding messages recorded on loop tapes on miniatrue, portable tape players. The human recorded voice provides immediate reinforcement as well as changeable, recorded messages that can be easily accessed by single switch contact via direct select or scanning methods of input. The direct select mode requires the placement of the switches with its corresponding picture/symbol onto the wheelchair tray itself. The student directly touches the picture/symbol to indicate his/her desired item. The mounting of the short message communicator device would be located under the wheelchair tray. The scan mode requires a panel with three LED lights connected to a single switch with standard miniature photo plug. The student presses the switch on the desired item that is highlighted as it scans across the panel. The selection resutls in the pre-recorded message corresponding to that particular switch.

Figure 1: The limited communication device. The scanning element with LEDs are shown at the bottom.

SUMMARY OF IMPACT

Although only limited time was spent field testing the bread-board version of the Limited Communication Device, our results indicated that a variety of representational symbols, or icons, could be easily interchanged according to the student's cognitive abilities. The assortment of inter-changeable, textured switch contact points allows for flexibility in matching the site of activation to the student's limited motor abilities. These features adequately meet the needs of speech-motor impaired students as they begin to control their environment via their social communication skills.



TECHNICAL DESCRIPTION

Figure 2 shows the circuitry for the Limited Communication Device. The D-type flip-flops shown at left are connected in a ring-counter configuration. The counter sequentiallya ctivates each LED cycling at a rate determined by a 555 timer (U4) configured as a clock. When the LED corresponding to the desired action is active (turned on) depressing a switch (PBI) will cause a logical high to be present on one input of the three NAND gates (7400). Only the gate that also has the logic high from the ring-counter will have a logic low at the output. This one channel will be active causing a 555 timer circuit to activate a relay which ill be capable of turning on a tape recorder other switchable device connected to the output. As the relay circuit is activated, a voltage is sent back via an interter (7406) which is connected to the reset pin of the 555-clock circuit. When the output of any of the inverters goes low the clock stops thereby leaning the selected LED on. This locking out, because any further depressing of the switch (PBI) will not effect the operation, is maintained until the activated 555 timer circuit turns off. Since each channel is independent with respect to the timer circuits and relay circuits the time on period for each timer can be set to the period required for that channel/device adding flexibility. The initial application was to allow the child to turn on one of three tape recorders with prerecorded messages to allow the child to socially interact (messages such as "Hello, how are you?"). With additional work programmable digital audio devices could be incorporated into the circuitry to provide for a more portable, compact system which will be easier to set up for the needs of a particular child by software manipulation. The total price of the system shown in figure 2 including the tape recorders is approximately $200.00. Although the initial application was limited communication the device can be used for other uses by connting other switchable devices to the output.

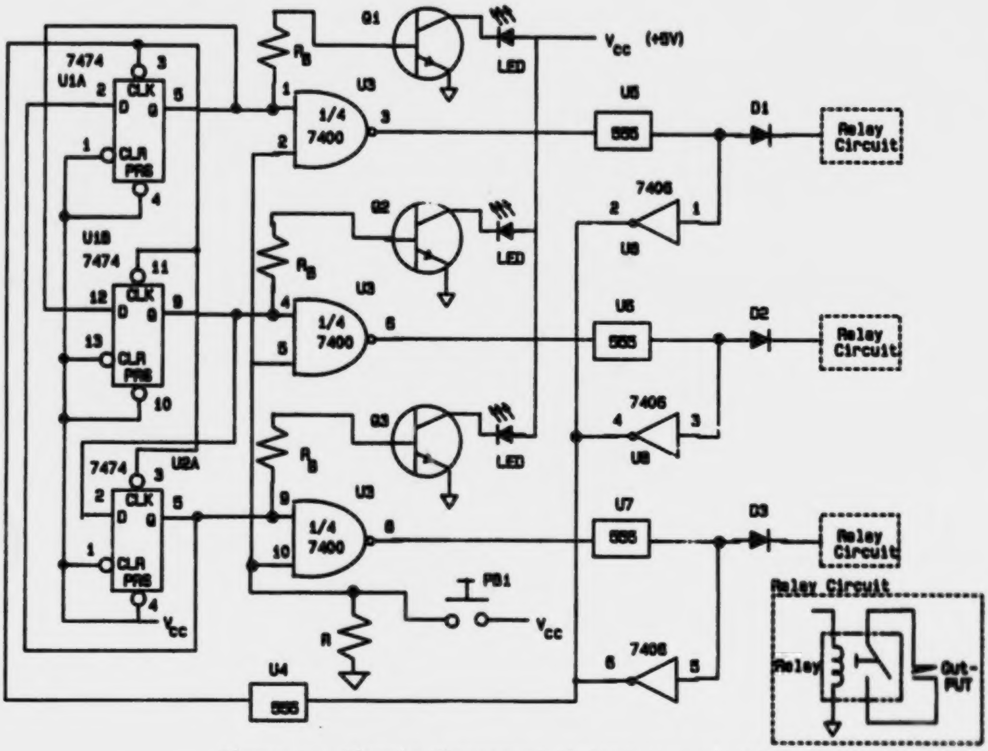
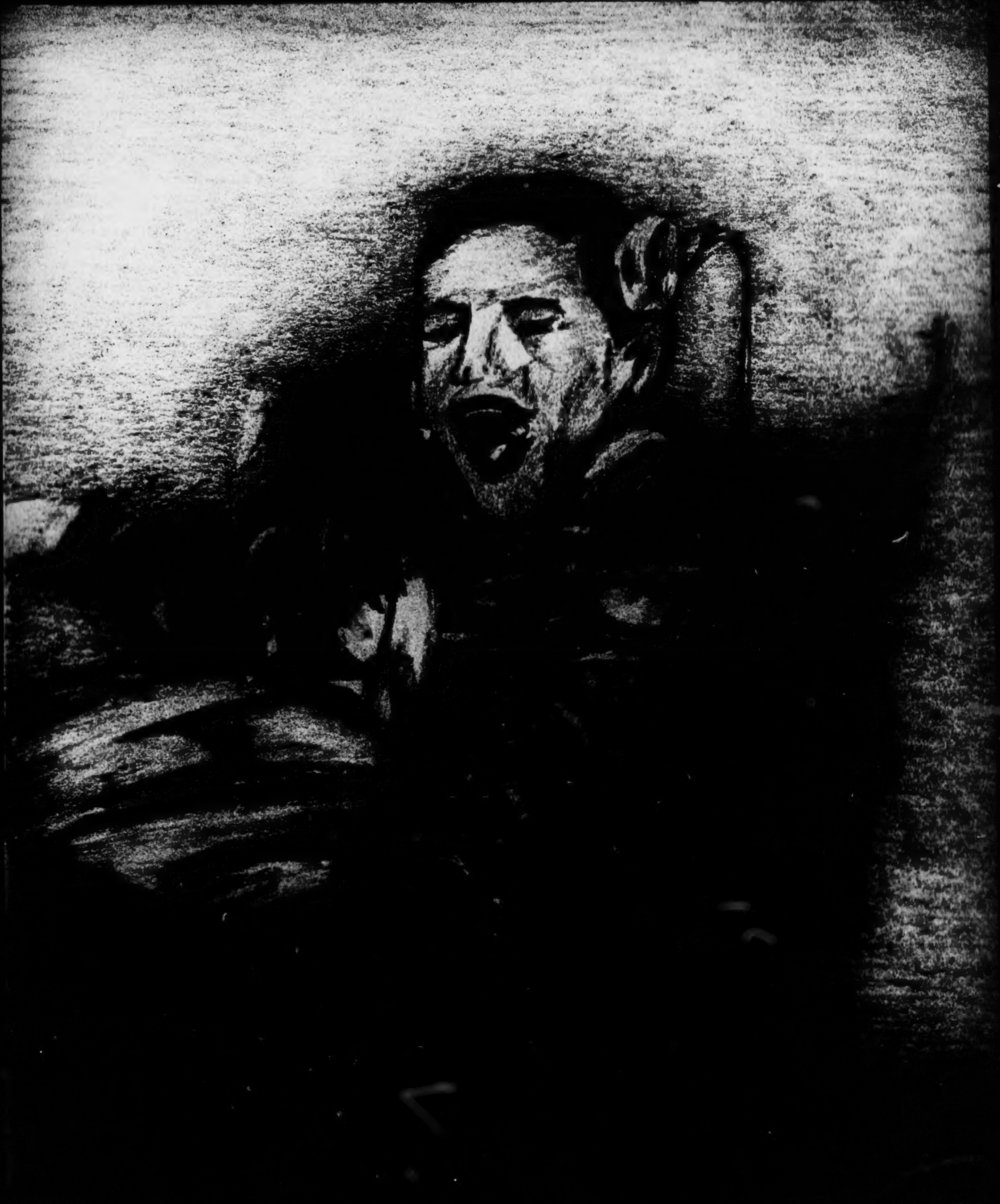


Figure 2: Circuit diagram of limited communication device. The isnert in the lower right hand corner of the figure shows the relax circuit with the output connection for the device (rape recorder).

ACKNOWLEDGEMENT

This work was partially supported by U.S. National Science Foundation Grant EET-8807522.



CHAPTER 3

MONTANA STATE UNIVERSITY
COLLEGE OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING
BOZEMAN, MONTANA 59717

Principal Investigators:

R. Jay Conant (406) 994-2204

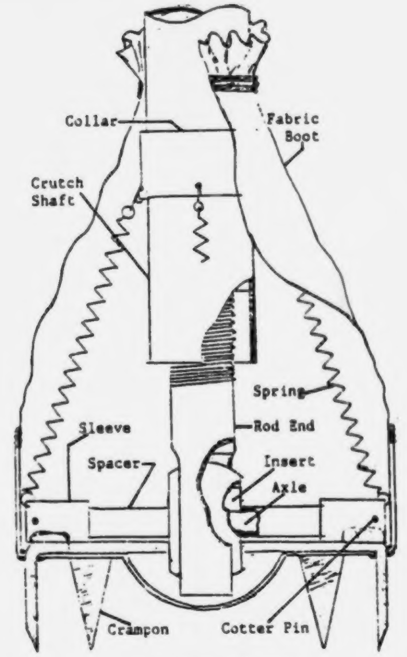
Michael K. Wells (406) 994-2204

"Ice Crampon Crutch Attachments"
Adaptive Ice Climbing Equipment for an Above-Knee Amputee

Designers: Wade Meyer, Lars Chrisman, Erik Stam
Faculty Advisor: Dr. R. J. Conant
Department of Mechanical Engineering
Montana State University
Bozeman, MT 59717

INTRODUCTION

The ice crampon crutch attachments are designed to allow an above-knee amputee to pursue the sport of ice climbing by providing positive, no-slip contact with an ice or hard packed snow surface. This is accomplished by modifying standard ice crampons so that they can be attached to the base of a pair of Loftstrand crutches. In order to maintain maximum contact with the ice surface the crampons are not mounted rigidly to the crutch but are allowed to pivot, much like a human ankle. Springs return the crampon to a neutral position after pivoting.



VIEW LOOKING FORWARD

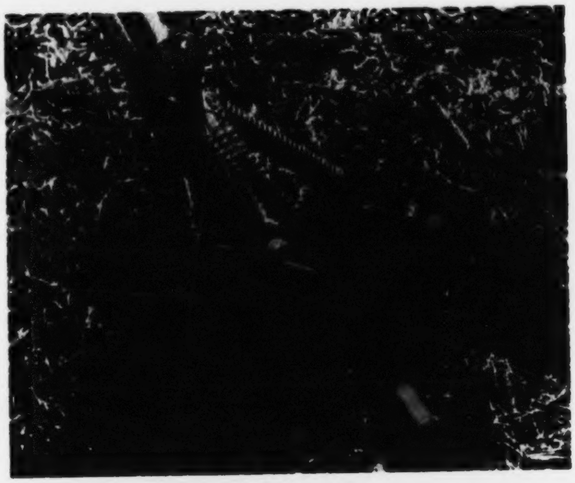
SUMMARY OF IMPACT

Our client had the following comments:

"The crampons allow me to ski terrain which can only be reached by climbing and hiking. For the first time I have the mechanical means which allow me to climb major peaks such as Mount Rainier, Dinali and peaks in Nepal.

I have never had adaptations which I felt were dependable and designed for maximum use in harsh conditions. These crampons are lightweight and give a sense of security and dependability. These are important factors, especially when I'm in a situation where the lack of these factors can be dangerous and physically and mentally draining.

Finally, the ability to climb large mountains and ski steep terrain is in keeping with my love for adventure and the excitement of pushing myself to a new limit. These are important elements in my life."



TECHNICAL DESCRIPTION

This device was designed around a pair of Salewa 2 piece adjustable crampons. The rear piece was discarded, leaving 8 points to contact the ice surface.

Previous ice climbing by our client was done with a pair of crutches with crampons welded to them. Since the crampon was rigidly attached to the crutch, the crampon could not pivot to conform to the slope of the surface. Consequently, on moderately steep slopes, where maximum contact is desired to provide the greatest support, not all of the points of the crampon were in contact with the surface. The weld joint between the crampon and the crutch was also an area of high bending stress, and both crutches ultimately broke at this location. In order to avoid these problems it was decided to allow the crampon to pivot at its attachment point with the crutch. It is essential that the pivot point be located as close to the ice surface as possible. Otherwise, the vertical forces acting at the pivot point through the crutch will tend to roll the crampon over. A 5/8" rod end with spherical bearing (obtainable at bearing supply houses) was chosen as the pivot device over other devices (such as a ball and socket or a universal joint) because it enabled the pivot point to be located at the top of the crampon ... essentially on the ice surface.

The rod end is attached to the crampon by an axle which passes through the spherical bearing of the rod end and through sleeves welded to the crampon. Spacers keep the rod end centered on the crampon and the axles are retained by cotter pins through the sleeves. The amount of movement of the crampons in the roll direction is determined by interference between the axle and the rod end housing. In order to maximize this movement a 5/16" axle is used and the bore of the spherical bearing is reduced from 5/8" to 5/16" with an insert.

Four springs attached to the crutch shaft and to the front, back and sides of the crampons serve to return the crampon to position perpendicular to the crutch shaft when it is lifted from the ice surface. Spring tension is adjusted by sliding the collar attaching the springs to the crutch along the length of the shaft.

The crampons and rod end assembly are covered with cordura nylon fabric to keep snow and ice out of the pivot mechanism. The portion of the cover on the underside of the crampon also serves to distribute the load when the crampon is used on snow, thereby limiting the amount that the crampon sinks into the snow.

Ice crampons typically are made from hardened steel and come with a hard epoxy finish. Welding of hardened steel results in a weak weld joint and also weakens the parent metal. Therefore prior to welding the epoxy finish should be burned off with an oxy-acetylene torch, and the crampon then annealed. After welding the crampon is austenitized and tempered to regain its original strength.

The cost of the ice crampon crutch attachments is about $220.00, excluding the Loftstrand crutches. Of this amount about $120.00 is for parts and the remainder for labor.

"Touch Window Lower-Case Letters and Shapes"
Drill and Practice on Lower Case Letters with A Touch Sensitive Device

Designer: Jim Gartzka
Rehab Professional: Linda Botten, OTR, Occupational Therapy
Associates of Bozeman & Livingston
Supervising Professor : Donna McClelland
Computer Science Department
Montana State University
Bozeman, MT 59717

INTRODUCTION

The Touch Window Lower-Case Letters and Shapes programs display a lower case letter or a shape on the monitor of an Apple II computer. A person then traces a letter or shape. The program tests the trace to determine if the person has followed the correct pattern and if the pieces have been traced in the correct order and direction. A successful trace is indicated by the picture disappearing and a happy face being displayed.

The programs will be used by children or adults with mobility impairments to practice forming the lower case letters of the alphabet.

SUMMARY OF IMPACT

Clinically, this tool is very effective. It provides the child with a sensorimotor feedback approach to learning. The see, they hear, they feel. They must hold their pen using a mature pencil grip, place adequate pressure, and evidence good visual motor control to do their letters correctly. This is important feedback for these children with motor difficulties. Children enjoy working independently and this allows them that freedom but still gives them feedback as to whether they have completed the task accurately.

TECHNICAL DESCRIPTION

The Letters and Shapes programs use a Touch Window (manufactured by Personal Touch, a Division of EDMARK Corporation) as the input device. This touch sensitive device fits over the monitor on any Apple II series computer. The Touch Window attaches to the monitor with Velcro tabs and plugs into the game port. If there is no external game port on the computer, most Apple dealers can provide an adapter for a minimal charge. Personal Touch markets a Toolkit for the Touch Window that provides the interface programs for developing software utilizing the Touch Window.

The Letters and Shapes programs were developed on an Apple II-Plus computer using BASIC to create the graphics images and control programs. Adding the interface code with the Touch Window was carried out on an Apple IIGS using the Toolkit.

The programs are stored on five diskettes. Each diskette is bootable with four diskettes providing portions of the alphabet (a-g, h-n, o-t, and u-z) and the fifth diskette providing the shapes. To use any of the programs, insert a Letters/Shapes diskette in the disk drive. Turn on the computer (or perform a warm boot) to load the program. An introduction message will be displayed followed by a request to "Press any Key". The next screen is a two option menu (Run the program or Quit). If the Run option is selected, the next screen is a calibration screen for the Touch Window. This is the same calibration screen that is used with all programs using the Touch Window. Two plus signs will be displayed one at a time. The person touches each spot to complete the calibration. The program is now fully loaded and the hardware is calibrated. The next screen is a menu of letters or shapes. After the person selects one of the letters or shapes, the object is displayed.

The letters are displayed between two solid lines with a broken line mid-way between them. This is patterned after the paper used by children when they start learning to form letters. The person must know the correct starting position and direction for tracing each letter. (The definition is according to the D'Nealian writing style.) If the person lifts the pencil, a beep is heard. If the person moves outside the error limits for forming the letter, starts in the wrong location, omits a part of the letter, or traces the pieces in the incorrect order or direction, a different beep is sounded. This tells the person to restart the letter. Upon completion of a successful trace, the screen goes blank and then a happy face is drawn.

After successful complete of a letter, the person can press any key to trace the same letter again or can press the ESC key to return to the menu of letters. The ESC key can be used at anytime to return to the menu.

Running the shapes program is identical to the letters programs except in the following areas:

a. When the shape is displayed, the starting point for tracing the shape is shown on the screen.
b. All horizontal lines are traced left to right.
c. All vertical lines are traced top to bottom.
d. All curved areas are traced clockwise.
e. When a mistake is made, the picture is erased and then displayed again. This tells the person to restart the trace.

The Touch Window currently sells for about two-hundred dollars. To obtain the Letters and Shapes programs, contact Nancy Procter, Department of Mechanical Engineering, Montana State University, Bozeman, MT, 59717. The only cost for the programs will be a handling fee to cover purchasing diskettes, reproducing diskettes, and mailing.

"TRI-SCOOTER"
A Mobility Device for a Child with Arthrogryposis

Designers: Debra Follensbee, Dean Markiss, Cary Munger
Rehab Professional: Arlene McKinnon, RPT
Bozeman Physical Therapy Center
Supervising Professor: Dr. R. Jay Conant
Department of Mechanical Engineering
Montana State University
Bozeman, MT 59717

INTRODUCTION

The Tri-Scooter is a mobility device that can be used by handicapped individuals who have difficulty in using a standard wheelchair because of reasons resulting form the inability to bend the leg at the knee, thus making indoor maneuverability in a seated mobility device awkward and difficult. The tri-Scooter is also ideal for handicapped children since this mobility device is much less stigmatic than the standard wheelchair. In addition, the fact that the device is powered and yet simple to operate provides reliability and independence to its handicapped operator.

Commercially available devices that meet the requirements of the handicapped individual with "fused" knees are virtually nonexistent, and devices that do exist that might be adapted for this use are expensive to purchase and are too complex for their intended use.

SUMMARY OF IMPACT

The child for whom this scooter was designed has already demonstrated success with the operation and steering of the scooter and has also stated that she is very pleased with the scooter. This child will be able to use the device for school outings such as field trips and possibly some mobility within the halls of the school building, for recreational activities such as outings with peers and family, and for activities that will increase her independence such as going to the store by herself. The design of the device makes it a sturdy and rugged device so that this child will be able to use the scooter for many years.

TECHNICAL DESCRIPTION

The three wheel scooter in this design is an alteration of a commercially purchased two wheel scooter found in any bike shop or department store. The rear wheel is cut off and an additional wheel purchased to allow for the creation of a three wheel cart. The existing frame is modified by the addition of lightweight chromium-molybdenum tubing (used in bicycle frames) to allow for the structural support of the wooden base. Due to the desired seated position, rather than the standing position used in the scooter, the entire steering assembly is removed and re-welded in a lower position. The scooter is designed to be 25 inches at the widest point which allows more than ample room to easily navigate through doorways and yet provides sufficient stability against tipping. The scooter has an overall length of 50 inches so that it can access any normal wheelchair lift. The seat is designed to be adjustable in height to increase the usefulness of the mobility device over time.

A D.C. electric motor powers the left rear wheel via two sprockets (tooth ratio=3:1) and a chain. The electric motor draws its power from two 12 volt deep cycle batteries. The batteries are encased in battery boxes which protect the user from acid spills, prevent accidental battery terminal shorts, and allow for easy removal of the batteries for transportation of the mobility device. The battery boxes are strapped to the scooter during use with quick release straps to prevent slipping.

Propulsion is achieved by pressing a button located on the left grip of the handlebars. The switch is spring loaded so that the user must constantly hold down the button to allow power to reach the motor. This will cause the scooter to stop should the left hand be removed from the handlebars thus introducing a safety factor if the operator momentarily loses control of the device while in motion. A disc was machined for the button surface to create a larger contact area and allow the operator to use the palm or fingers to press the power button.

Braking is performed with the right hand using a standard braking system, found on all bicycles, provided with the commercial scooter. The brake-on-the-right, power-on-the-left configuration was chosen since the this child's right hand is her stronger hand and thus a brake on this side is safer.

To insure that the child will not be required to dismount the scooter to overcome obstacles, a forward/reverse switch is incorporated between the handle bars to allow for increased maneuverability especially inside buildings.

The Tri-Scooter is designed with two speeds to allow the scooter to have inside-outside usefulness. A switch toggles the system between 24 volts (series batteries) and 12 volts (Parallel batteries). When the motor is powered by the twelve volt system it travels at speeds between three and four miles per hour, which is adequate for any indoor application. In addition, the increased current provided by the parallel connection will increase the power output of the motor allowing for increased performance and pull on hilly terrain. When the motor is powered by the 24 volt system it can achieve a maximum speed of 6.8 miles per hour. This speed is too fast for indoor applications but is convenient for outdoor uses when traveling from point to point.

A key switch added to the scooter cuts the power to the motor and thus insures that the device will not be tampered with when not in use.

A standard automotive battery charger was altered to allow the mobility device to be plugged into a charging system without the need for connecting and disconnecting battery cables.

The overall cost of this device, not including labor, is approximately 500 dollars. The major expenditures, in order of decreasing cost, are the batteries, the scooter, the motor, and the charger. These components account for well over half of the overall cost of the mobility device.

The overall weight of the device is about 150 pounds with the two batteries accounting for over 100 pounds. Thus when the batteries are removed the device can be easily placed in a van or pickup for transportation.

"Support Walker"
A Walker Designed for Handicapped Children that are too Small for Commercially Available Walkers

Designers: Paul Chausse, Keith Meadows, Jim Olszewski
Rehab Professional: Linda Botten, OTR, Occupational Therapy
Associates of Bozeman & Livingston
Project Adviser: R. Jay Conant
Mechanical Engineering Department
Montana State University
Bozeman, MT 59717

INTRODUCTION

The Support Walker is an adaptation to a commercial walker for non-handicapped children. Because there are no commercially available walkers for small handicapped children, they are forced to wait until they are bigger before they can start developing the muscles and coordination needed to walk. This device allows these children to begin learning to walk at the same time non-handicapped children begin walking.

The Support Walker consists of a commercial walker that has a backboard and a trunk support built onto it for upper body control. The trunk support is connected to hinges that allow a person to open and close the supports around the child. The hinge is attached to the backboard with velcro so that it can be adjusted to the proper location on the child.

This device will primarily be used in therapy to help the child develop his muscles and coordination. Once he has developed these skills, the device can be used in the home to aid the child in moving around the house.

SUMMARY OF IMPACT

The child for whom this walker was designed has cerebral palsy which does not allow him to walk or stand independently. This is due to decreased stability of his upper trunk and hips, and decreased strength of his legs and ankles.

Therapeutically supported dynamic standing would improve his stability and stimulate the extensor musculature allowing him increased stability throughout his body. Currently there is no appropriate commercially available standing device to suit his needs.

The walker which was adapted for this child enables him to stand erect with proper support, to place weight symmetrically on his feet and to improve his visual focus to look upright. He not only has improved his ability to bear weight but also has improved his upper trunk extensor muscle tone to keep his head erect.

This walker will continue to be beneficial as he begins to shift weight in standing, and to gain strength in his legs as he bears weight on his feet.

TECHNICAL DESCRIPTION

The walker itself is a standard commercial walker for small children that is available in most department stores. The only requirements that this walker must meet are the maximum weight and the tray surrounding the child.

First, the child must not exceed the maximum weight that the manufacturers set for the walker. There are a variety of walkers available and a walker should be chosen to allow the child some growing room. Second, the tray surrounding the child must be durable. The reason for this is that the backboard is connected directly to the back of the tray and it must be strong enough to support it.

The backboard consists of a 4" x 10" x 1/8" steel plate. Seven and a half inches from the top of the backboard is a 1" x 2" x 3/4" steel plate welded perpendicular to the first piece. The backboard is then padded and bolted to the back of the walker.

The trunk support is made up of two pieces of 1/8" aquaplast thermoplastic and two hinges. The thermoplastic is approximately 3" wide and 7" long. When the thermoplastic is set in hot water it becomes very pliable and can easily be formed to the child's upper body. As it cools it then becomes rigid and stays in its predefined form. The thermoplastic is then riveted to the hinges which have been welded together. The hinges are used so that the rigid thermoplastic can easily be opened and closed around the child. Sleeves have been attached to thermoplastic pieces. Velcro has been attached to the sleeve which is used to connect the two pieces of thermoplastic. This provides the necessary upper body support to keep the child in an upright position.

The trunk support is then connected to the backboard with the use of velcro. A strip of velcro has been attached to the length of the backboard and to the hinge. This has been done so that the trunk support can be adjusted to the proper location on the child.

The seat of the walker has also been modified for this device. Using the seat that comes from the manufacturer, the child sits too deep in the walker for the trunk support to function. Therefore, the seat has been modified in such a way that the child sits higher in the walker. The seat is also adjustable so that the height of the child and the trunk support can be located in the optimum position for therapeutic reasons as well as the comfort of the child.

The final modification of the device is to the commercial walker itself. In some cases it may be necessary to raise the walker. In this case, spacers can be placed on the underside of the tray, between the tray and the cross member bars. Three inches should be the maximum needed. If more is needed, the child will fit into a commercial walker.

The total cost of the support walker is two hundred twenty-nine dollars and thirty-nine cents ($229.39). The seat modification had a total cost of eighty-three dollars ($83); eight dollar for material and seventy-five dollars for the upholstery work. The backboard had a total cost of fifty dollars ($50); forty dollars for the steel and machining costs and ten dollars for the upholstery work. The trunk support cost a total of forty-six dollars and thirty-nine cents ($46.39); eleven dollars and sixty cents for the thermoplastic, thirty dollars for the labor of the therapist to form the thermoplastic and four dollars and seventy-nine cents for the hinges and strapping. Finally, the commercial walker that was used had a total cost of fifty dollars. The cost of this device can easily be reduced in many areas. The cost of the walker itself may be reduced by buying a different brand. The machining and upholstery costs can be reduced by having non-professional people perform the necessary tasks.

MECHANICAL WHEELCHAIR RESTRAINT
A Mechanical Device for Locking a Wheelchair in the Driver's Position of a Van

Designers: Alan Johnson, John Clairmont, Jason Cunningham
Rehab Professional: Mike Mayer, Director, Summit Independent
Living Center, Missoula, MT
Supervising Professor: Dr. R. J. Conant
Department of Mechanical Engineering
Montana State University
Bozeman, MT 59717

INTRODUCTION

The wheelchair restraint is a device which is used to hold a manual wheelchair stationary in the driver's position in a van. The primary component of this device is a Golden-Boy over-center locking mechanism. The upper end of the apparatus mounts to a bracket on the chair between the user's legs. The lower end hangs down to the van floor. When the chair rolls into the driver's position (i.e. up to the steering wheel), a grommet slips over a floor mounted hook. The user then simply pulls up on a handle which activates the locking mechanism. When the user is ready to move away from the steering wheel, a second handle is pulled which activates a release mechanism.

The device will be used by a person with advanced quadriplegia. Commercially available hydraulic and electric devices did not meet the requirements of this gentleman.

SUMMARY OF IMPACT

Our client made the following comments regarding this device: "I am pleased with the outcome of the project. The new tiedown design allows me to fasten my chair down and release it much more quickly than was possible before. I find that I do not waste nearly as much time in operating the tiedown. Any device that saves me time or energy definitely enhances the quality of my life. The new tiedown design to date has proven very satisfactory. I am sure that it will continue to do so in the future."

TECHNICAL DESCRIPTION

The wheelchair restraint apparatus consists of 3 separate parts. The first part is a hook which is mounted to the floor of the van. This hook is 3/4" in diameter at the base and tapers to 1/4" at the tip. Due to the limited vertical clearance of the user's wheelchair (the bottom of the solid footrest is less than 2" above the floor), the hook was designed to be 1.5" high with an inside diameter of 1". The base of the hook is threaded and fits through a 3/4" hole in the floor of the van. It is held in place by a lock washer and nut.

The second piece of equipment is a Golden-Boy over-center device. Certain modifications were made to this device to facilitate its use. The first is the attachment of a grommet to the bottom of the device. When in the secured position, this grommet attaches to the hook that is mounted in the floor. This grommet has an inside diameter of 1.35" and is constructed of .25" steel. The next modification is the mounting of a stopping mechanism which prevents the lever arm from falling past a position where it would no longer be parallel with the floor. This enables the grommet to be in a set position while the device is moving forward to attach to the hook. Attached to the end of the lever arm is a nylon rope which is used to lock the device. The rope is threaded through a series of eyelets mounted on the threaded shaft of the device. These eyelets insure that the rope doesn't become entangled with the apparatus or the release line. The release rope is attached to a lever which is mounted on the device with a hose clamp. When the handle on the release line is pulled, the release mechanism pushes the lever arm out of the locked position. The release rope is also threaded through a series of eyelets similar to the locking rope. The last modification to the over-center device is the attachment of an extended handle to the threaded shaft with two small hose clamps. This enables the user to more easily hook the device through a plate that is mounted on the wheelchair.

The third and final part of this apparatus consists of a .25" thick steel triangular plate mounted to the user's wheelchair. This plate is mounted between the user legs on a bar that extends across the frame of the wheel chair. The plate has a hole drilled in it through which the over-center device is attached.

For the device to operate correctly there are a few steps that must be followed. First, as the user maneuvers the wheelchair into the van, he must place the hook on the end of the over-center device through the hole in the triangular plate. This is accomplished by using the extended handle. After this is done, the user moves the wheelchair forward into its final position. While the user is maneuvering forward, the grommet slides along the floor and comes to rest underneath the hook. The final step in securing the wheelchair is pulling on the handle of the locking rope. This pulls the lever arm up and locks the over-center device. The handle on the release rope is pulled after the user has reached his final destination. Then the user can back the wheelchair out of the driving position.

The cost of the total apparatus is $250. This includes the cost of the Golden-Boy over-center device and also machining costs.

The modifications to this device were designed with a particular user in mind. Since this is the case, the apparatus may have to be varied to meet the needs of different users.

"Spring-Assisted Leg Extender"
A Device to Rotate and Lock/Unlock Leg Braces Used by a Young Child

Designers: John Roy, Curt Rauscher, Charles Whittington
Rehab Professional: Arlene McKinnon, RPT
Bozeman Physical Therapy Center
Supervising Professor: Dr. Michael K. Wells
Department of Mechanical Engineering
Montana State University
Bozeman, MT 59717

INTRODUCTION

The spring assisted leg extender is a device that enables a young boy with mental retardation who walks with the aid of leg braces and a walker to extend and lock the braces independently. A lever system was designed that is attached to the standard bale lock brace. When the child is in a sitting position the lever is pushed forward causing the knee to extend and the brace to lock.

SUMMARY OF IMPACT

The client has had the knee locking devices in place for several months at this time. He is demonstrating both an understanding and a capability of locking his knee braces using this device. The child will consistently perform this activity when cued to do so and seems to enjoy the activity. A training program has been initiated to enable the child to not only lock his braces independently but to rise to a standing position independently. This design has met the criteria set for it and is allowing this child to work toward the goal of independent initiation of gait.

TECHNICAL DESCRIPTION

The locking devices are designed to attach to a pair of leg braces that use a standard bail lock. As seen in the drawing, the device consists of a lever which attaches to a cam that pivots about a point on the upper part of the brace. The cam pulls on a cable which is attached to a pulley mounted on the knee joint of the brace. A torsional spring which aids in the locking of the brace is contained in the pulley.

The locking device is designed to be used from a sitting position. When a force is applied to the lever the cam rotates (counterclockwise, as seen in the photograph), causing the cable to rotate the pulley (clockwise, as seen in the photograph). This action loads the spring which is located in the pulley housing. When the spring is fully loaded, continued application of force to the lever raises the lower portion of the brace toward its locked position. As the brace approaches the locked position the stored spring energy assists in the actual locking of the brace. After the braces are locked the levers can be returned to their starting position, which is parallel to the upper portion of the leg brace. The total rotation of the levers needed to lock the brace is about 100 degrees.

The pulley housing and its cover are made of aluminum. The torsional spring, which is contained in the pulley housing, is made of high carbon steel. The housing cover protects the user from getting fingers pinched in the spring. The pulley is attached to the knee joint of the braces and makes use of the existing hole in the brace, although a longer bolt is required to accommodate the thickness of the pulley housing.

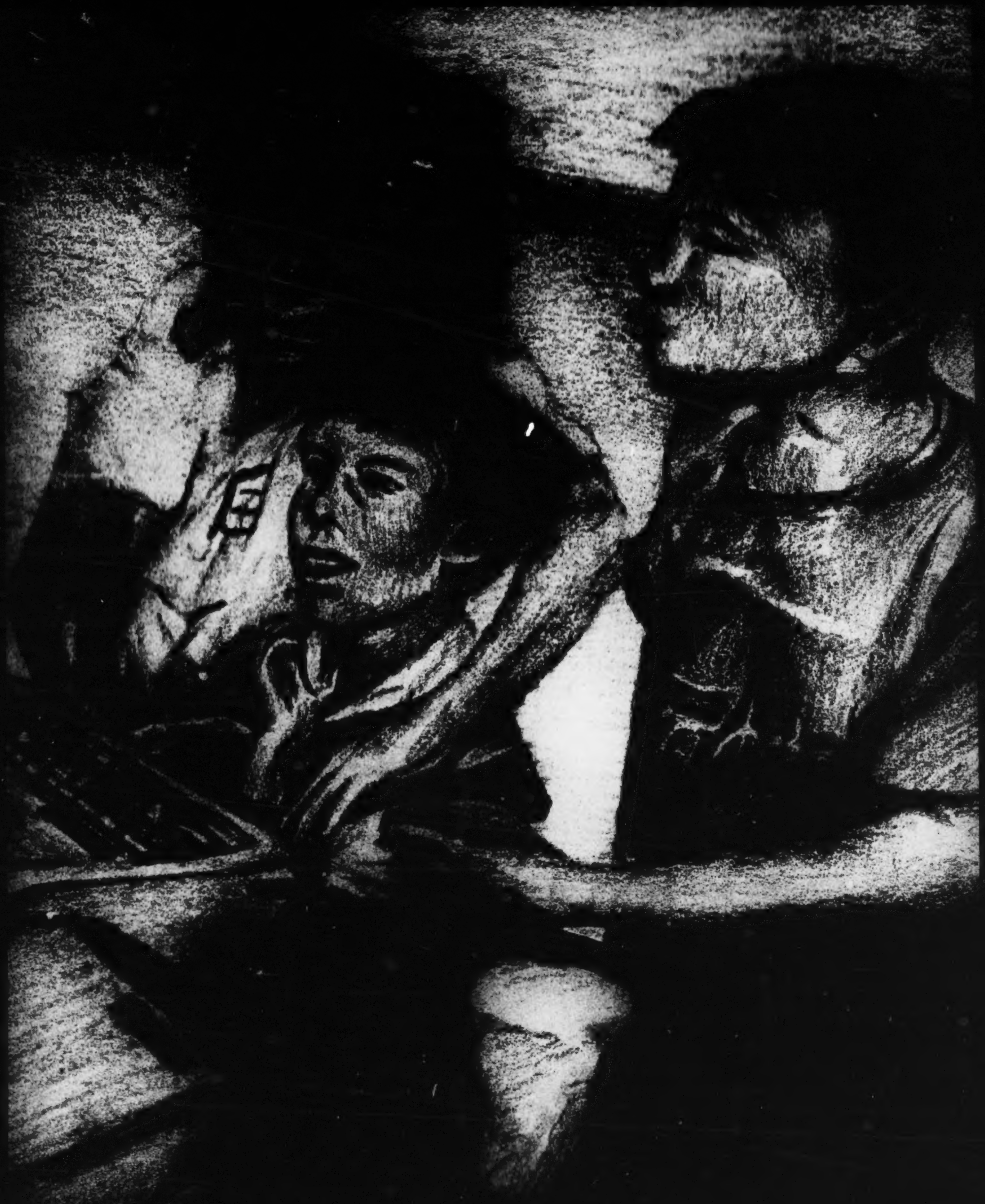
The cable is a standard bicycle cable. The end of the cable that attaches to the pulley uses the connector supplied with the cable while the other end, which attaches to the cam, is fitted with a prosthetic cable end connector. A nylon sheath covers the cable.

The cam, which is made of aluminum and attaches to the upper portion of the brace through an existing hole, serves to keep the force required at the lever somewhat uniform as the lower portion of the brace is raised.

The lever consists of two parts. A stainless steel extension with one end threaded attaches permanently to the cam. The handle is made of aluminum and threads onto the extension. It can be detached from the extension when not needed. Because it is detachable the handle can also be readily replaced to accommodate growth in the user.

Each locking device weighs about a pound.

Total cost of the two locking devices is around $100.00, not including labor costs.



CHAPTER 4

New Mexico State University
College of Engineering
Department of Mechanical Engineering
Las Cruces, New Mexico 88003

Principal Investigators:

Raymond A. Willem (505)646-2117

"Accessible Work-Holder"
A Wheelchair Accessible Work-Holder for Shop Use

Designers: D. A. Aden, G. L. Leshikar, M. A. Md. Ali
Disabled Coordinator: Jim Thompson, Las Cruces Public Schools
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

In a work-shop setting, a person in a wheelchair often has difficulty in fully accessing a work piece for drilling, painting, sanding or other operation. Many work benches have a skirt, lower shelf or inconveniently placed legs that do not allow convenient wheelchair access.

The Accessible Work-Holder has been developed to satisfy this need. It provides two stations where different types of clamping devices may be located – perhaps a toggle clamp on one and a vise on the other. The work stations are located at opposite points of a diamond-shaped frame while the frame is supported by columns at the other two points of the diamond as shown in the photo. Therefore, this design eliminates any obstructions below the work station and provides more than 270° of access in the horizontal plane. The work stations can be adjusted in height by moving the frame vertically on the supporting columns. The work piece can be rotated about a horizontal axis and tilted in almost any direction by means of locking ball-joints to which the toggle clamp and vise are each mounted.

SUMMARY OF IMPACT

The student for whom this was designed is a paraplegic who is mentally, as well as physically, disabled. The student has found the Accessible Work-Holder to add to the ease of doing certain kinds of shop work and it appears to promote more work with less fatigue. Also, tasks that could not be performed previously are now possible due to the improved accessibility and convenience provided by this device.

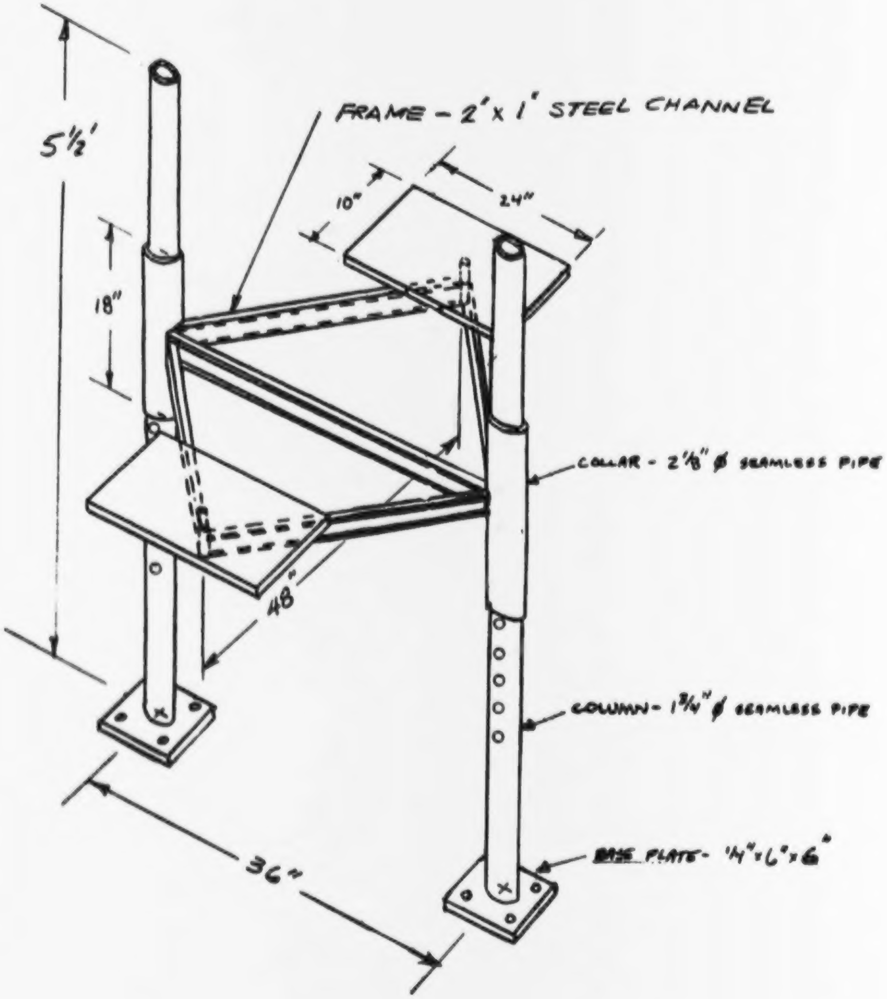
TECHNICAL DESCRIPTION

The Accessible Work-Holder is shown below in its basic form. The diamond shaped frame has dimensions across its opposite points of 36 x 48 inches. At the points where the work stations are located, the lengths of steel channel are welded to short pieces of steel tubing. These pieces of tubing provide a seat for the shank of a platform (as shown in the drawing) or locking ball-joint (as shown in the photograph). In either case, the shank is locked to the seat by a hand screw.

At the other two opposite points of the diamond shaped frame, the three pieces of channel joining at those points are welded to 18 inch lengths of steel pipe called collars. These collars are an integral part of the frame and provide the locating surface for moving the frame vertically on the columns.

The frame is positioned vertically by placing a nut and bolt in the appropriate thru-hole in each column that will maintain the frame at the desired height. The holes in the columns (but not the nuts and bolts) are shown in the drawing.

Finally, it is necessary to attach the columns solidly to a base so that they are parallel to each other. In this case, a wood base was used. The vise, toggle clamp and locking ball-joints are purchased items. The approximate cost to build this device is $500.


5½'
FRAME - 2" x 1" STEEL CHANNEL
10"
24"
18"
COLLAR - 2⅛" ø SEAMLESS PIPE
48"
COLUMN - 1¾" ø SEAMLESS PIPE
BASE PLATE - ¼" x 6" x 6"
36"

"Multipurpose Desk for a Quadriplegic Engineer"

Designer: Ram B. N. Prasad
Disabled Coordinator: E. J. Hoskins, M.D., Ph.D.
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

A desk was designed and fabricated which met the needs of a specific quadriplegic engineering student who was soon to graduate. In addition to meeting his professional needs, the desk also had to be convenient to move when the student relocated after graduation.

The desk had to provide an accessible computer work station, writing area and book storage area and all of these areas had to be easily accessible from one another. While performing these various functions, the desk also had to be relatively compact and, as already mentioned, easy to move.

To provide for accessibility, the desk is totally supported along its ends and back edges thus removing all underneath obstructions. Compactness is achieved by using an L-shaped design for corner placement, locating the computer keyboard on a sliding tray and making good use of the corner of the L by placing the printer and paper supply in that location. The book storage is made accessible by placing it forward on the desk, in front of a storage area which, unfortunately, is not accessible by the student.

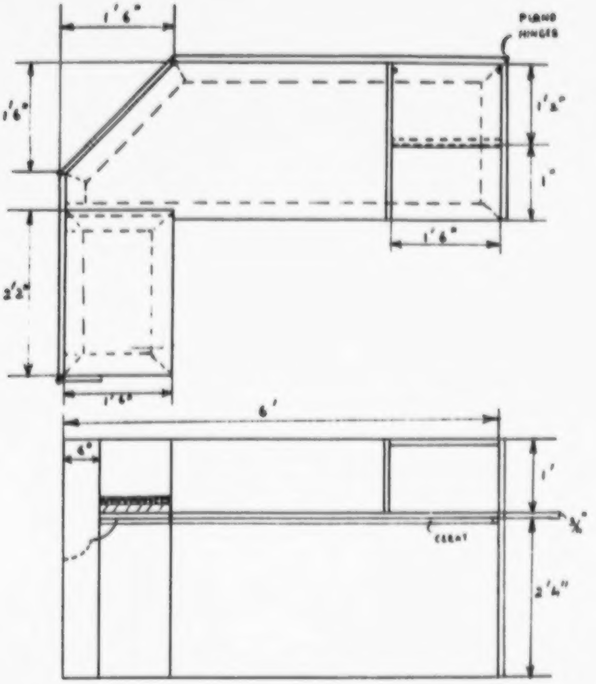
The vertical surfaces are connected to one another by piano hinges. The desk may be disassembled by removing a few screws connecting the horizontal with the vertical surfaces and then folding the vertical surfaces along the piano hinges.

SUMMARY OF IMPACT

The designer of this desk, himself a student, spent a large amount of time with the quadriplegic recipient while obtaining design information. Also, as the concept for the desk evolved, the student recipient was kept informed and asked for input. As a result, the recipient was aware of the general design when fabrication began. However, he was obviously surprised and delighted at how very well the completed desk met his needs. In addition, he found it aesthetically very pleasing.

TECHNICAL DESCRIPTION

The basic material used was $\frac{3}{4}$ inch medium density particle board with an oak veneer. The desk working surfaces were covered with a high pressure laminate. The shelf for the printer paper supply (1) can be lifted off the desk and the supporting brackets folded under. The approximate cost of making this desk was $950.


1'6"
PIANO HINGES
1'6"
1'2"
1"
1'6"
2'2"
1'6"
6'
4"
1'
$\frac{3}{4}$"
CLEAT
2'4"

"A Special Desk for a Special Student"

Designers: M. Mackie, E. Erpenbeck, M. Al-Quidahi
Disabled Coordinator: A. Curtis, Las Cruces Public Schools
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

A sixth grade boy in the Las Cruces Public Schools was born without arms and with one leg three inches shorter than the other. He has adapted well to his handicap. For example, he has learned to write with his foot by gripping a pencil or pen between his toes. He is able to attend regular school without great difficulty, but among his disadvantages was his inability to use a regular school desk. He wrote by sitting on one chair while writing on the seat of another chair facing toward him, a rather inadequate situation.

A student design group, after studying the problem in depth, designed a desk specifically to meet the needs of this student. Among its features are a writing surface at an optimum height and angle. The writing surface has a mat finish which inhibits slipping of the paper. Also, the desk has two drawers and a sliding bookshelf which have been designed to be accessible by the student.

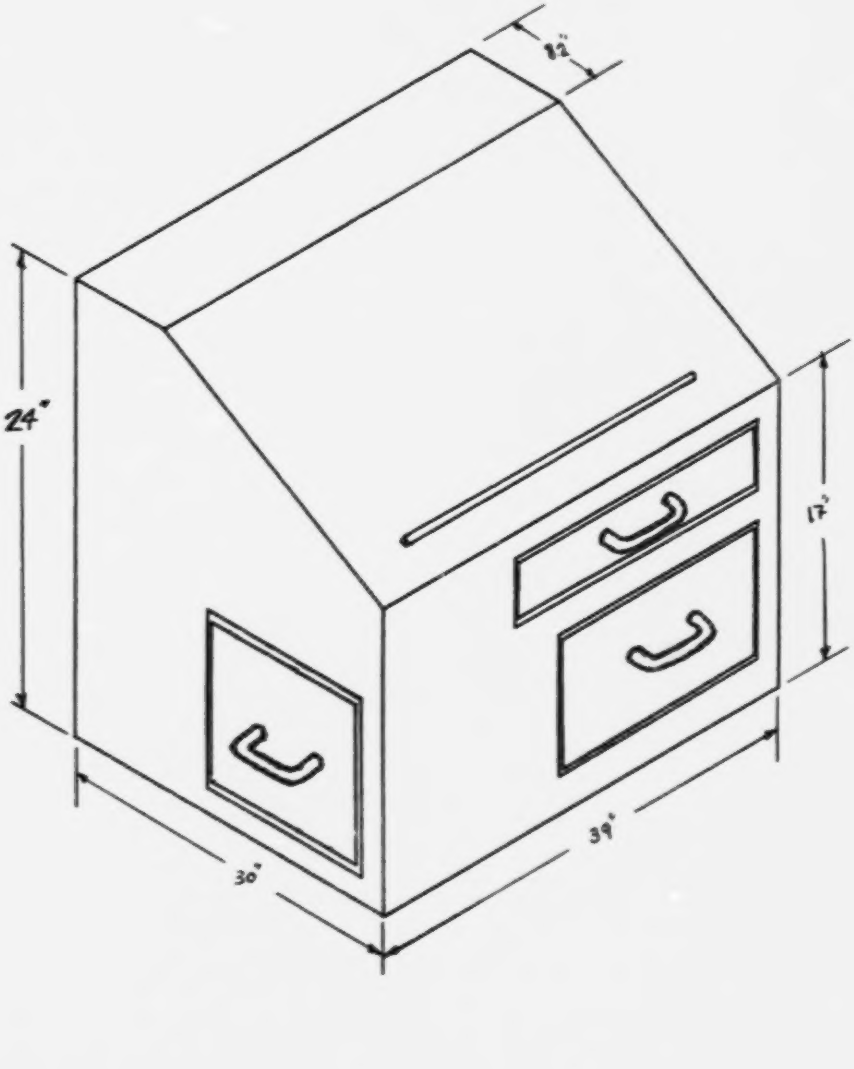
SUMMARY OF IMPACT

The handicapped student was pleased with the desk from the beginning. The convenience and pleasure that it has added to his performance of school tasks – reading as well as writing – is evident. He is now able to sit in a comfortable position when doing school work and he has space in the drawers and bookshelf to store his things. He feels sufficiently attached to the desk that it troubles him when his homeroom teacher allows other students to use the desk.

TECHNICAL DESCRIPTION

The drawing below gives the essential details of the desk. The basic material for the desk is $\frac{1}{2}$ inch plywood. Using the dimensions shown produces a writing surface angle with the horizontal of 18°. The drawer pulls were selected to be easily pulled by foot. In spite of the depth of the lower front drawer, it is fully accessible by the student. What appears to be a drawer in the side of the desk is not a drawer but a sliding bookshelf. It is similar to a drawer in design but has the side facing toward the front of the desk missing. In that way, books can be accessed easily by the student while sitting in front of the desk.

The cost of making this desk was approximately $375.



"A Motion Activated Toy"

Designers: S. Owen, V. Assai
Disabled Coordinator: M. Dawson, Las Cruces Public Schools
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

A girl in the Las Cruces School System of about 5 years of age is seriously mentally and physically handicapped. She is able to hit a dangling object while lying on her side, however, she often lacks motivation to do this. It was thought that her action of striking a dangling object could be made to operate a battery operated toy for some short period of time and, thus, provide her with additional motivation. Also, it would help her develop the idea of "cause and effect".

The problem required that a dangling object be presented to the child in a safe and aesthetic fashion. When the object is struck lightly in any manner, this should have the effect of turning on a battery operated toy for some period of time between 10 and 30 seconds. These goals were achieved with a system that suspends a tennis ball from a cord in an easily struck position. Motion of the tennis ball causes an array of mercury switches located at another point on the cord to momentarily close a circuit. This activates a timer model and allows a battery operated toy to operate for a predetermined period.

SUMMARY OF IMPACT

It required some time to introduce the child to the device and to develop consciousness of the ball and toy simultaneously. It appeared after time, however, that the child did develop some connection between the two events.

TECHNICAL DESCRIPTION

The frame for suspending the tennis ball and switch (see photo) is made of polyethylene pipe and fittings. The tennis ball is suspended by a nylon cord which also supports an aluminum box containing three mercury switches. The mercury switches are connected in parallel with one another so that closure of any one or combination of switches will activate the timer module. The three switches are oriented so that any small angular displacement will cause at least one of the switches to close.

The original timer module was designed by the students and was operated from a 9V AC to DC converter. This timer, however, developed reliability problems after some time and it is planned to replace it with a ready-made module (likely one marketed by Steven Kanor, Ph.D. Inc. of Hastings, NY).

The timer module closes the circuit of the battery operated toy. However, the timer module only provides the switching function for the toy. The power for the toy is supplied by batteries housed in the toy. The timer module is introduced into the electrical circuit of the toy by means of a battery interrupter, a device composed of a cable with a jack on one end which plugs into the timer module and a disc on the other end. The disc is a laminate of two metallic outer wafers separated by a wafer of insulation. When slipped between two batteries, the disc insulates the batteries from each other and allows the circuit to be switched at the jack.

The cost of making this device using the purchased timer module and not including the toy is approximately $80.

"Wheelchair Placement in Car Mechanism"

Designers: J. R. Sanders, W. J. Wilson, A. S. Siraj
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

This device is to assist a paraplegic with limited upper body strength in placing a wheelchair on the passenger side of the front seat of a car. The device is portable and is hung from the rain gutter on the front passenger side of the car before each use. It is electrically powered from the cigarette lighter socket and is operated by a hand held controller that contains a forward-reverse switch and an on-off button which turns off when released.

To use it, the person transfers from the wheelchair to the passenger front seat. After placing the device on the rain gutter and plugging it into the cigarette lighter socket, the caster wheels of the folded wheelchair are raised and placed inside the door sill. Then the spool on which the strap is wound is disengaged from its shaft by sliding the spool toward the front of the car. Sufficient strap is reeled off the spool to allow the end loop to be placed over the push handles of the wheelchair. The spool is reengaged with the shaft by sliding it rearward and with the switch in the forward position, power is applied by depressing the on-off button. As the wheelchair is pulled into the car, it is necessary to guide its motion. Once in the car, the loop is removed from the push handles and the free strap is wound back onto the spool and the device is stowed.

SUMMARY OF IMPACT

The paraplegic user finds that this device avoids the need of struggling to get a 40 lb. wheelchair into his car. As a result of its lightness, compactness and good design, he also finds it remarkably convenient to use.

TECHNICAL DESCRIPTION

The Wheelchair Placement in Car Mechanism weighs 4 lbs. and has over all dimensions of 3.0 x 4.8 x 4.8 in. The heart of the device is the 12 volt Model 4Z837 ($\frac{1}{90}$ HP) Dayton Gearmotor rated at 40 in-lb with a 191.6:1 gear reduction and 12 rpm speed. The motor drives the spool shaft through a 1:1 miniature chain drive enclosed by the cover on the left end. The spool shaft rotates in plain bronze bushings pressed into the inverted U-shaped frame. The axial position of the spool shaft is maintained by the two collars enclosing the bearing on the right side. The spool is made of aluminum and has two positions on the shaft. The spool is shown in the driving position in which a slot in the left end of the spool engages a shaft pin. The spool is maintained in this position by means of a spring loaded ball in the spool engaging a circular groove in the shaft. The spool becomes free-wheeling when moved from the position shown to the right end of the shaft.

An electrical connector for the motor is mounted in the frame and provides a connecting point for the wire going to the control box and cigarette lighter plug-in. The cost to make this device is approximately $500.

"Folding Cane for the Sight Impaired"

Designers: P. Zeman, T. Borland, A. Abdaljabbar
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

The sight-impaired often use a cane to assist in finding their way around. The single-piece fiberglass cane is very popular because it is light weight and relatively flexible. These characteristics contribute to its ease-of-use and sensitivity in determining the nature of the terrain. Canes which have multiple pieces and are foldable or collapsible have the advantage of being compact when not in use but at the same time become more heavy and stiff and, therefore, have diminished effectiveness in performing their principal function.

The goal of this project was to develop a cane that could be easily compacted and reassembled by a blind person and which was approximately as easy to use and effective as a single piece cane.

SUMMARY OF IMPACT

This project was undertaken to assist a sight-impaired female university student. She wanted a can that could be compacted to a size that would fit in a large hand bag yet would be approximately as effective as the single piece cane. This would avoid the problem of having to lay the cane on the floor when not in use and having passersby trip or step on it.

The recipient of the cane finds it totally successful in meeting its objectives. Not only does it feel essentially like the single piece cane from which it is constructed but it can be folded or reassembled in 5 seconds with little difficulty.

TECHNICAL DESCRIPTION

The principle component in fabricating this cane is a standard tapered fiberglass cane with a rubber-mounted metal tip. This can is cut into four approximately equal pieces. Then the handle portion on the largest diameter piece is cut off making the part that remains relatively short.

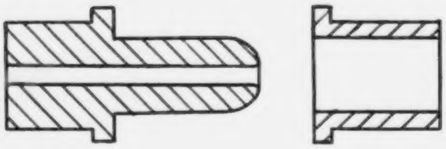
Three joints of the design shown are machined to join the four pieces. Note that each joint is a different size since the original cane was tapered. The fit between the two aluminum pieces of each joint must be snug to avoid mechanical looseness in the finished cane. The joints are fixed in the ends of the fiberglass pieces with epoxy. The large end of the short fiberglass section is epoxyed into the handle as indicated on the handle drawing.

Teflon-coated, 50 pound test nylon fishing line has been used to thread the four sections together and always maintain them in their proper order. When the cane is in its extended configuration, it is the line under tension that pulls the cane sections together.

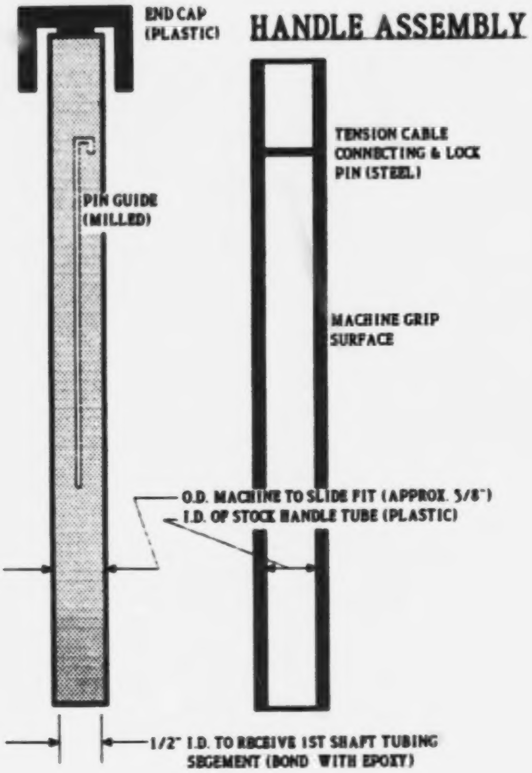
Final assembly of the cane sections is achieved by taking an eight foot length of fishing line and tieing a small helical tension spring to one end. With the handle end cap removed, the outer handle tube section (without the pin in place) can be assembled over the inner tube. Then the pin is placed into the outer tube so that it engages the pin guide in the inner tube and also catches the free end of the helical spring (with line) which has been placed inside of the inner tube. The line (attached to the other end of the spring) is then threaded through the other cane sections and will be anchored in the inside of the tip section. The line is cut to length and anchored so that when the pin (in the handle) is at the bottom of the pin guide and the sections are unjoined (the condition in the photograph), the line is extended but without tension.

To put the cane into its extended configuration from the compact configuration, the cane is allowed to hang down while being held with one hand by the black part of the handle (outer tube). Then with the other hand, the inner tube is pushed into the outer tube and rotated. This causes the pin to rise into the inverted-J portion of the guide slot and locks the cane in the extended configuration.

The cost of fabricating this cane was $40 not including machining time.



TWO PIECE JOINT (ALUM.)


END CAP
(PLASTIC)
HANDLE ASSEMBLY
TENSION CABLE
CONNECTING & LOCK
PIN (STEEL)
PIN GUIDE
(MILLED)
MACHINE GRIP
SURFACE
O.D. MACHINE TO SLIDE FIT (APPROX. 5/8")
I.D. OF STOCK HANDLE TUBE (PLASTIC)
1/2" I.D. TO RECEIVE 1ST SHAFT TUBING
SEGEMENT (BOND WITH EPOXY)

"Voice Loudness Indicator"

Designers: J. Ruiloba, H. Ottenhoff
Disabled Coordinator: N. Lowe, Las Cruces Public Schools
Supervising Professor: R. Black
Electrical and Computer Engineering Department
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

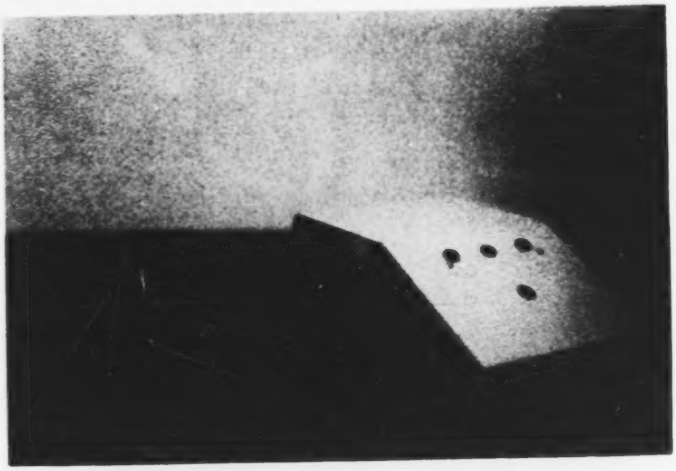
The Voice Loudness Indicator monitors voice loudness and activates a red, green or amber light depending on whether the voice is too loud, sufficiently loud, or too low, respectively. It has a gain control which permits adjustments to compensate for the placement of the device relative to the speaker.

In use, the device is placed so that the sloping front panel containing the lights and the microphone is facing the speaker. After an initial gain adjustment, the speaker can then use the device to help him/her moderate their voice. On the back side of the device is an LED array which allows the person facing the speaker (speech pathologist perhaps) to also monitor the loudness indication.

SUMMARY OF IMPACT

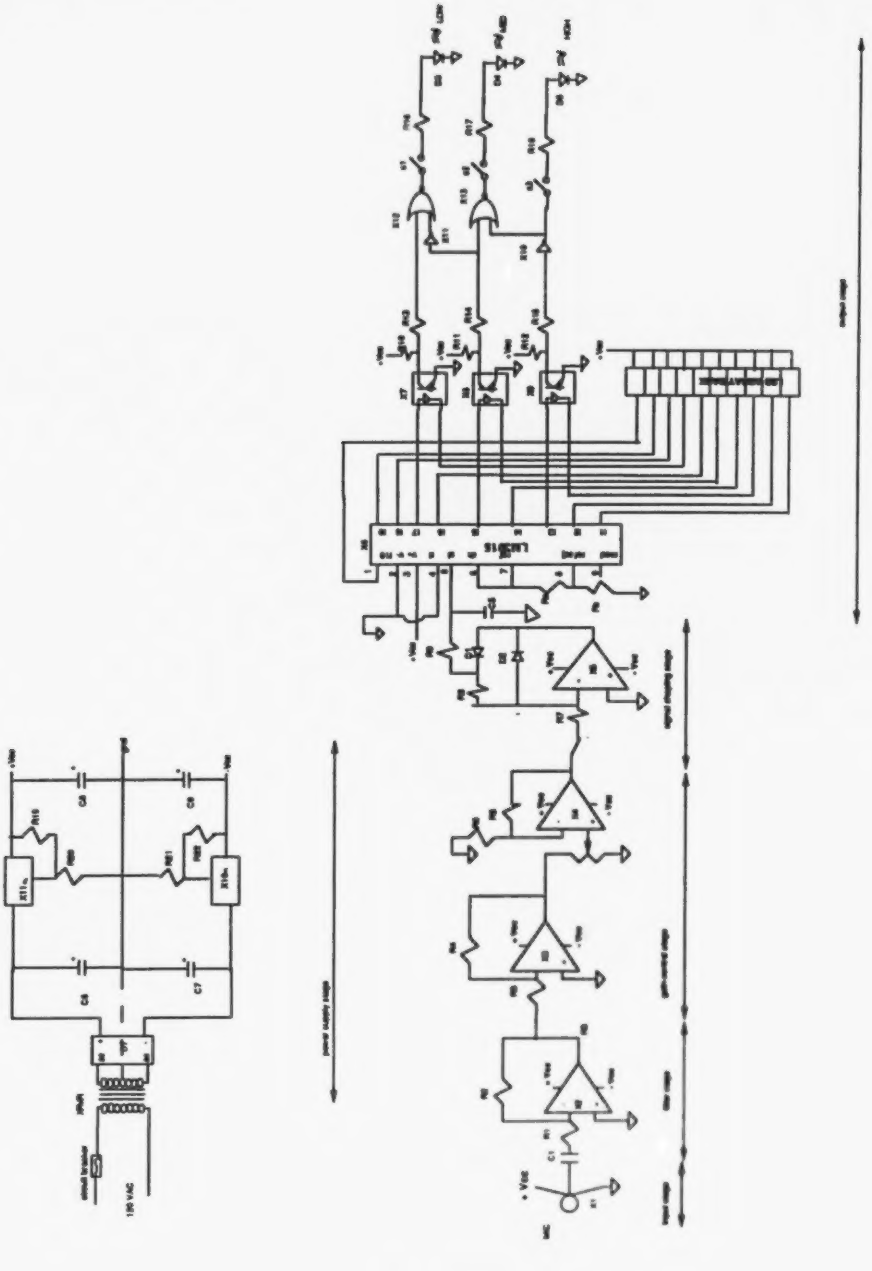
The client is an eighteen year old boy who is multiply impaired with autistic tendencies. He has prosody of speech (rhythm and intonation) problems which leads to difficulty in controlling speech loudness. His tendency is to shout.

He has taken enthusiastically to using the device and it has had a marked effect in reducing the loudness level without voice distortion. It has also made him somewhat conscious of maintaining a moderate voice level when not using the device.



TECHNICAL DESCRIPTION

The schematic diagram of the Voice Loudness Indicator is shown below. The cost of fabrication was approximately $100.



"Accessible Door Closer"

Designers: R. Mackintosh, A. Morales, A. Haji Abdul
Handicapped Coordinator: D. Koehner, New Vistas Center
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

It is often difficult for a person in a wheelchair to close a door that they have just passed through. This is particularly true when the door opens into the room that the person is leaving.

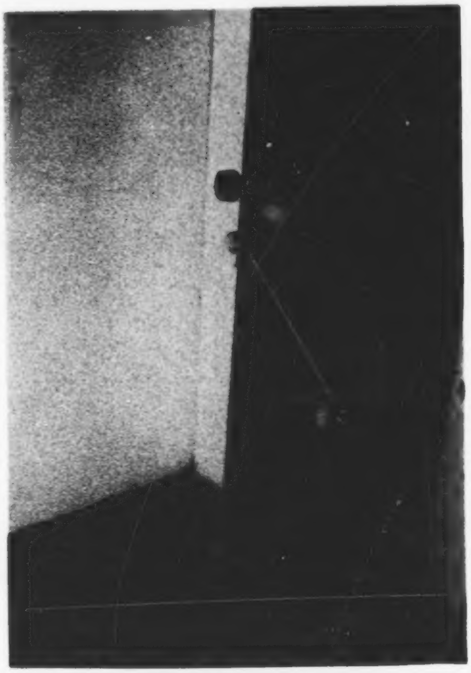
A simple device for solving this problem has been devised. It consists of a door hinge with a torsional spring bias such as is used on screen doors to maintain them in a closed position. This item, easily found in hardware stores, is on the back side of the door and, therefore, is not visible in the photo below. A simple hinge of this design, when installed on a light door, is sufficient to slowly move the door to the closed position.

When the horizontal slide (with the two knobs) is in its leftward position, the door will be held open to whatever extent it has been pushed open. The slide is put in this position by a person in a wheelchair before passing through a door. This will hold the door and allow unobstructed passage. Then, after passing through the door, the slide is moved to its rightward position and the door will swing closed under the action of the spring-biased hinge.

SUMMARY OF IMPACT

This is a very simple device that can be reproduced at little cost. In addition, it solves a wide-spread problem and solves it in a convenient fashion.

The client for whom it was designed is pleased with it and is making the design known to other people in wheelchairs.



TECHNICAL DESCRIPTION

The spring-biased hinge is mounted on the back side of the door so that the axis of the hinge is colinear with the other hinges.

On the front side of the door is the simple mechanism shown in the photo. It consists of a pivoted door stopper with a short lever welded to it. A nylon string connects the end of the lever with the horizontal aluminum slide which moves in brackets attached to the door. The string is guided by eyelets which are placed on the door so that, as the slide is moved to the right, the door stopper is raised out of contact with the floor. This allows the door to swing closed under the action of the spring biased hinge.

When the slide is moved to the right position, the door stopper falls under gravity into contact with the floor. In this position, the door may be opened but the stopper prevents it from swinging closed. The cost of this device, not including installation, is about $25.

"A Kinetic Toy Array"

Designers: L. Mamiya, C. Brown, S. Hernandez
Disabled Coordinator: S. Buse, Las Cruces Public Schools
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

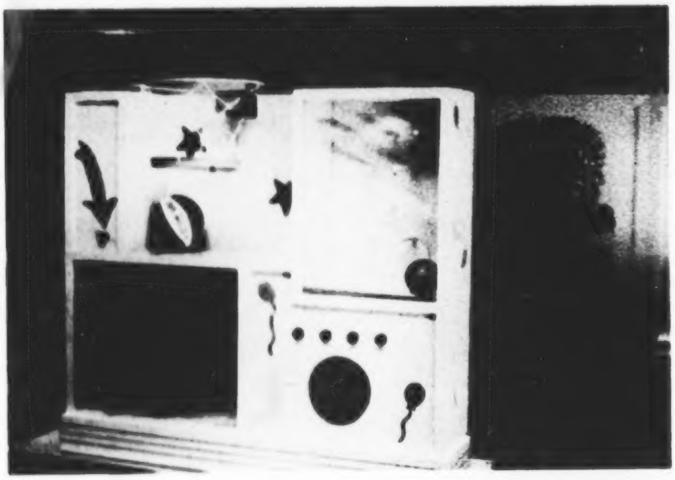
INTRODUCTION

The goal of this project was to develop an array of toys to engage a handicapped child with a short attention span. It was considered desirable that the toys both involve the child motorically and produce motion, preferably of a varied or random nature.

An array of five toys were developed and combined in a single cabinet. Proceeding in a clockwise direction from the upper center, a miniature basketball toy was developed which produces five seconds of "celebration" noise each time a basket is made. Next to that is a ball-drop toy in which a ball bounces chaotically as it falls through a maze of dowels. Below that is a telephone dial which activates a line of blinking lights when it is rotated. In the lower right hand corner is a sand toy in which the colored sand and oil enclosed assumes a new configuration as the toy is rotated to a new position. Lastly, in the upper right hand corner is a toy in which colored confetti in a plexiglass box is agitated when a button is pushed. The agitation is produced by an upward current of air from a battery operated fan.

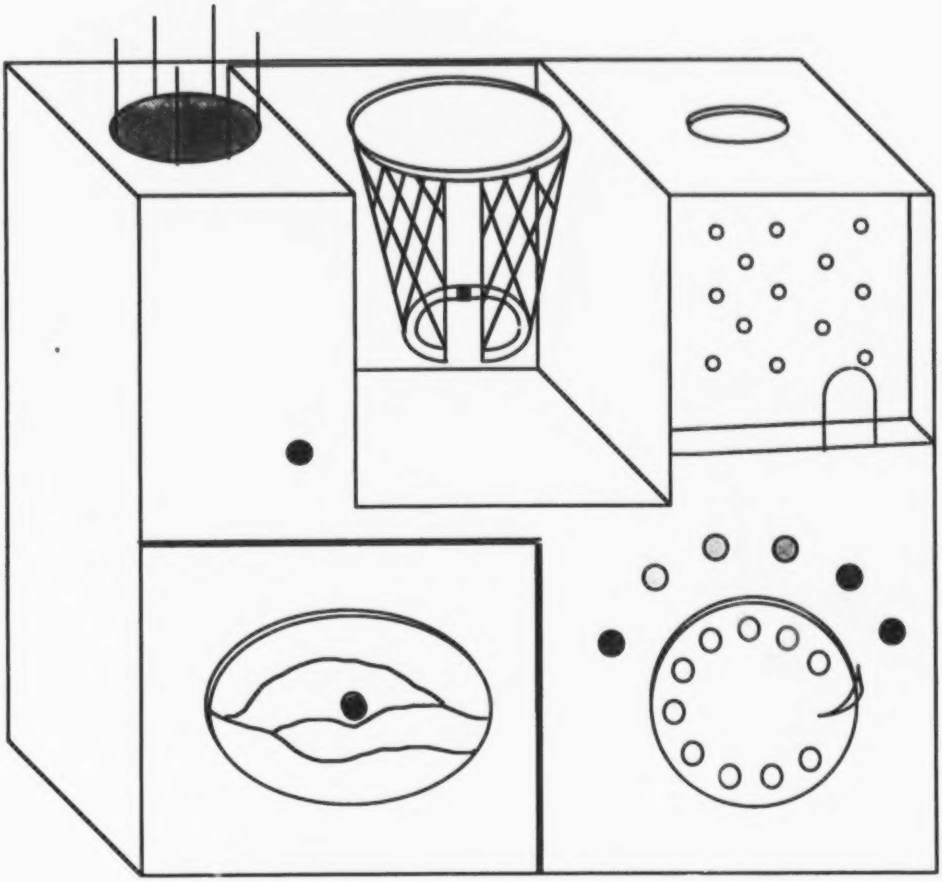
SUMMARY OF IMPACT

This array of toys was developed for a non-verbal, autistic child who is mentally handicapped. He has shown particular interest in the confetti and telephone dial toys and playing with these has helped him focus attention and develop eye contact. As this child is attention deficient, it is significant that he will spend in the neighborhood of a minute playing with these toys. Other handicapped children in his class have also had fun with these toys.



TECHNICAL DESCRIPTION

The dimensions of this array is approximately 3 x 3 x 1 ft. and weighs 30 to 40 lbs. It may be used on the floor or placed on a table top. The back of the cabinet is removable which must be done to replace the 12 volt battery which powers the telephone dial lights and the fan of the confetti toy or the two AAA batteries powering the noise maker. The cost of making this device is approximately $500.



"Basic Communication Device"

Designers: J. Corelis, S. Daugherty, B. Sawaged
Disabled Coordinator: K. Carlson, Las Cruces Public Schools
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

The outcome of this project was to produce a basic communication device operated orally in which a sip produces an audible "yes" while a puff produces an audible "no." The primary challenge was to do this at a low cost while producing a relatively compact, battery-operated device.

The unit has an adjustable goose-neck with a sip and puff straw at its end which the operator holds in his mouth. The straw is connected by a flexible plastic tubing to the pneumatic switch housed in a metal box. The metal box also houses the electronics of the unit. A soft carrying case accommodates the total unit.

SUMMARY OF IMPACT

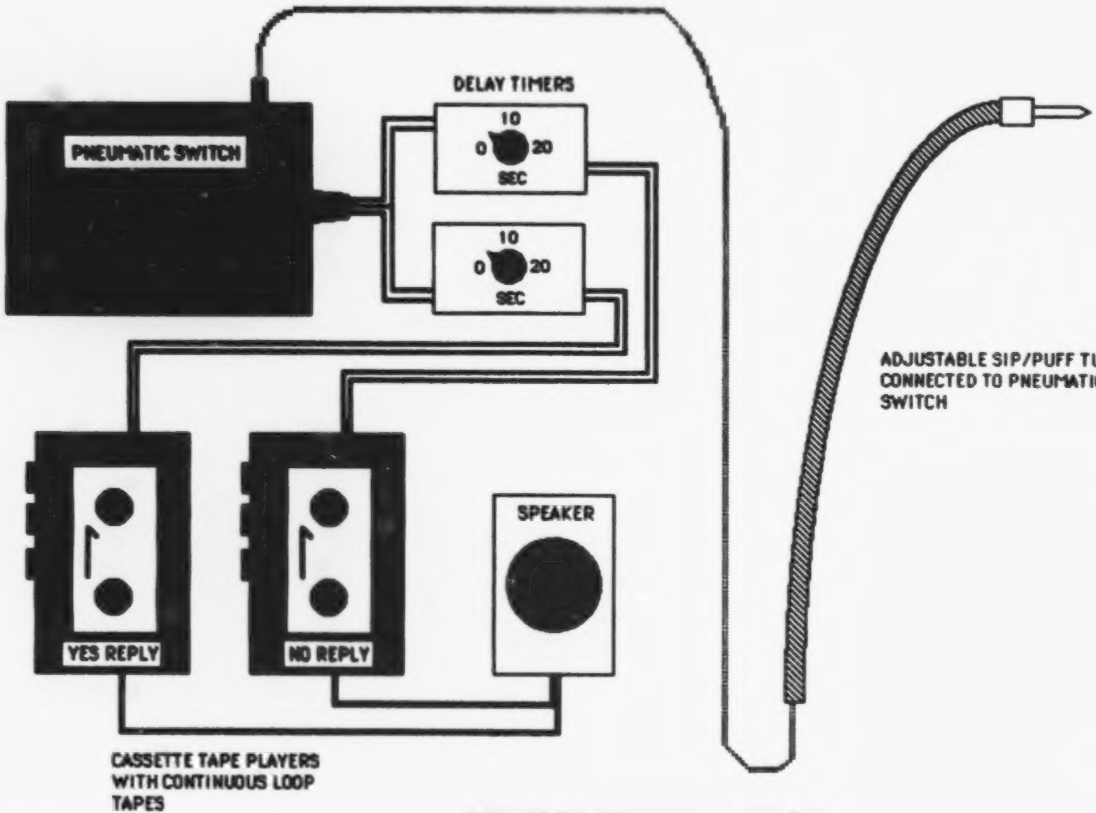
The recipient of this device is a young boy who has severe cerebral palsy and, in addition, is mentally retarded and blind. He has no speech but is capable of making some vocal sounds.

The child has been able to operate the sip part of the device put has yet to produce the puff response. Due to the severe condition of the child and his naturally low level of motivation, an extended period will be needed to work with the child in the use of this communication tool. The device, however, appears to be well suited to the disabilities of the child.

TECHNICAL DESCRIPTION

The schematic below shows how the various components comprising the unit are interconnected. The pneumatic switch and goose-neck were purchased from Prenke Romich Co. (model PS-2). The two delay timers were purchased from Steven E. Kanor, Ph.D., Inc. of Hastings, NY (model 00600). Either one or other of the delay timers is momentarily switched by a sip or puff to the pneumatic switch. That delay timer, under the action of the momentary pneumatic switch closure, closes another switch for a preset period of time (up to 30 seconds) which activates the cassette recorder connected to it. Each cassette player has a continuous loop tape, one with "no" and the other with "yes" recorded at intervals. Depending on which recorder is activated a "no" or "yes" comes out over the speaker.

The schematic does not show a double pole, double throw switch which switches the power to both timers, a small 9 volt battery in each timer. The cassette players are the kind used to power ear-phones and are operated by two AA batteries in each. The cost of making this unit is $450.


DELAY TIMERS
PNEUMATIC SWITCH
10
0
20
SEC
10
0
20
SEC
ADJUSTABLE SIP/PUFF TUBE CONNECTED TO PNEUMATIC SWITCH
YES REPLY
NO REPLY
SPEAKER
CASSETTE TAPE PLAYERS WITH CONTINUOUS LOOP TAPES

DEVICE TO PRODUCE A YES/NO RESPONSE FOR A SEVERELY HANDICAP CHILD

"Walker/Stabilizer"

Designers: J. Buntain, A. Martinez, D. Pruitt
Handicapped Coordinator: L. Anfinson, Las Cruces Public Schools
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

This modified walker aids a child without balance control to practice controlled, arm extended, balanced movement. The walker used in this project was purchased and then adapted to the specific need.

The objective in this case was to develop a device which promotes a forward leaning posture and a controlled resistance to forward movement while providing adequate lateral stability and contstraint.

SUMMARY OF IMPACT

The child for whom this walker was developed has severe cerebral palsy, is ataxic (poor balance and motion control) and has slight mental retardation. He is four years old, verbal, happy, and excited about having a walker.

He has taken to using the walker with enthusiasm. Presently, it is used as therapy device with the wheel brakes partially set to provide some pushing resistance.

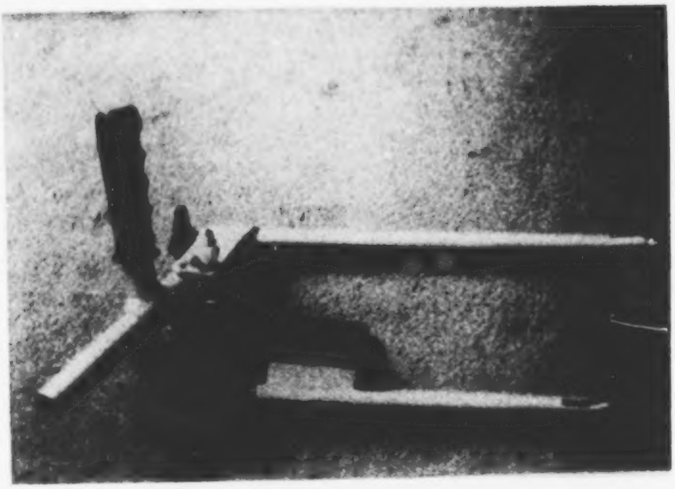
TECHNICAL DESCRIPTION

The basic walker which was modified is the product of Ortho-Kinetics and is model #6283. The name given to this model is "Jungman".

The modification involves replacing the standard walker "handles", which attach to the verticle tubes of the walker, with the "handles" shown below. These handles provide the interface between the walker and the child. They have seven degrees of adjustment:

- a vertical displacement and angular displacement with respect to the walker
- the arm support bar can be adjusted linearly and rotationally
- the hand grip can be adjusted linearly and rotationally
- the hand-grip/arm-supported bar can be adjusted angularly.

The walker was purchased used and cost $180. The fabrication of the modified parts cost $550.



"Page Turner"

Designers: S. Boyd, G. Gallegos, C. Martinez
Handicapped Coordinator: S. Watson, New Vistas Center
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

The intent in this project was to develop a device that would assist a woman who has partial arm mobility but virtually no finger mobility to turn pages. It is truly an assistive device in that it relies on the user's power. It is an interface which takes the limited unsteady motion of the user and converts it into motion to turn the page of a magazine or book.

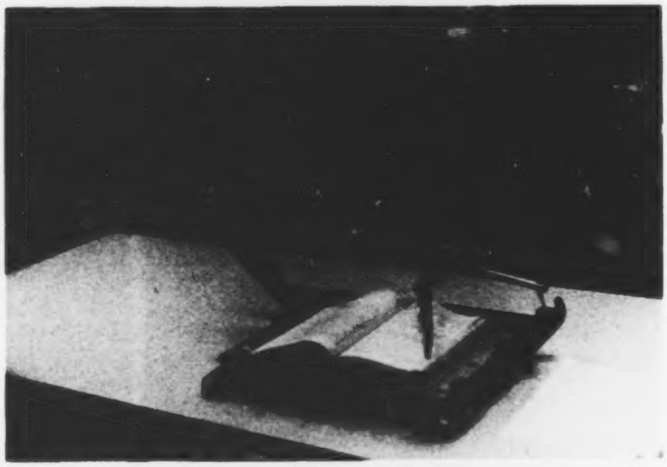
To use the device, the user places their hand on the slide which is guided by the crossways brass bar. The slide not only translates but also rotates on the bar. Attached to the slide is a long projection with a rubber eraser on the end. It is the eraser which contacts the paper. To move the eraser out of contact with a page simply requires that the slide be rotated to move the eraser upward. The eraser, in or out of contact with a page, is translated side to side by translating the slide.

Either a left or right handed user can be accommodated by adjusting the brackets holding the bar to the frame. The frame is made of wood and has plastic clamps to hold the book in position.

SUMMARY OF IMPACT

The recipient of this device is a head-injured woman of 27 years old who has suffered considerable motor impairment as a result of her injury, cannot speak, but appears to have suffered little or no mental impairment. Her limited arm and hand movement is sufficient to permit her to operate a device of this kind.

The recipient made use of the device for some matter of weeks, however, the design was not sufficiently robust to withstand long use. It failed to maintain the eraser in its proper position and also one of the brass rail supports fractured. It is anticipated that another student design group will resume development of this very practical and important device in the next school term.



TECHNICAL DESCRIPTION

This device was fabricated directly from sketches; therefore, the most useful documentation is likely photographs and the description of its operation given in the Introduction.

"Oven Temperature Setting Assistive Device for the Visually Impaired"

Designers: K. Nix, G. Silversmith, E. Manzanares
Handicapped Coordinator: M. Ruddy, New Vistas Center
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

Since a blind person is unable to see the numbers on the oven temperature control dial, another means must be used to make this setting. In this project a device has been designed and made which gives an audible indication of the temperature setting of an oven and it appears to be suitable for use on most ovens.

When installed on the oven for which it was specifically designed, the device makes a clicking sound for every 25° degrees of temperature increase or decrease.

SUMMARY OF IMPACT

This device was made for a young blind man with an M.S. in counseling.

He counsels the handicapped, particularly those with sight impairiments. It is installed on the oven control in the kitchen of his apartment.

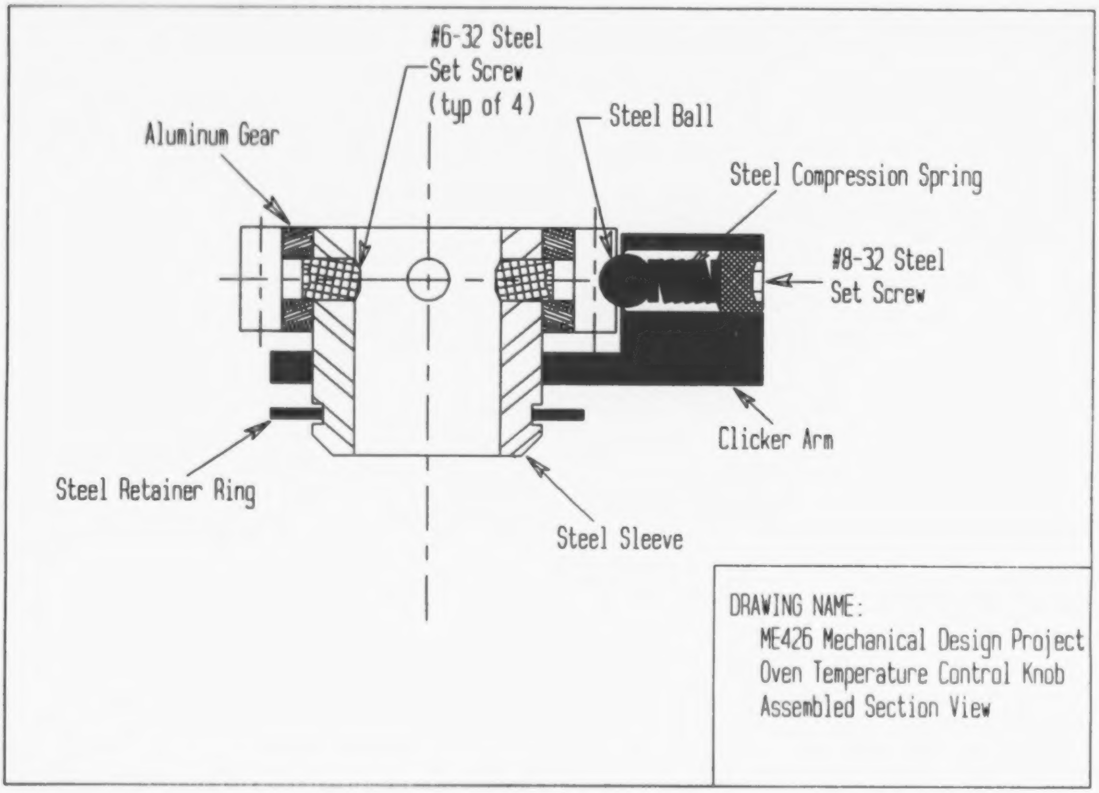
The device works to the client's total satisfaction and allows him to make use of his oven for things requiring accurate temperature control. Also, because of his professional work, he can make others aware that this kind of device is possible.

TECHNICAL DESCRIPTION

The device has three major parts: the clicker arm, aluminum gear, and steel sleeve. The steel sleeve is pressed into the aluminum gear and four equally spaced radial holes are drilled and tapped to accommodate four 6-32 set screws. The clicker arm rotates freely on the steel sleeve and is maintained on the sleeve by the steel retaining ring. The spring loaded ball in the clicker arm engages the teeth of the aluminum gear and it is the sound of the ball moving over the teeth that produces the clicking sound.

The device is installed by first removing the oven temperature dial and then placing the steel sleeve of the assembled device over the oven dial shaft so that the retaining ring faces out. Then the four set screws are tightened on the shaft so that the shaft lies as near to the center of the sleeve as can be achieved by eye. Then the head of the clicker arm is attached to the vertical front surface of the stove with epoxy or some strong adhesive. Finally, the oven dial is replaced and the device is ready for use.

The cost of the device is about $35 not including machining.


#6-32 Steel
Set Screw
(typ of 4)
Aluminum Gear
Steel Ball
Steel Compression Spring
#8-32 Steel
Set Screw
Clicker Arm
Steel Retainer Ring
Steel Sleeve
DRAWING NAME:
ME426 Mechanical Design Project
Oven Temperature Control Knob
Assembled Section View

"Measuring Device for the Visually Impaired"

Designers: C. Ober, B. Pete, D. Jaycox
Handicapped Coordinator: M. Ruddy, New Vistas Center
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

The device developed in this project allows a visually impaired person to make liquid and dry measurements conveniently in a kitchen setting. This device will measure a half cup of either liquid or dry material each time it is operated.

The device is used by pouring either liquid or dry powder into the funnel sufficient to fill it more than half way. Then the device is picked up by the handle with one hand and held over the container the material will be measured into. The other hand is used to rotate the piece of rigid plastic tubing suspended at top and bottom by the two elastomer valves. Each time the plastic tube is rotated through approximately a half revolution backward and forward about its vertical axis, a half cup of material will fall through the metering column.

When the measuring is done, any excess material remaining in the funnel may be poured back into its storage container. The funnel may be cleaned easily by rotating the plastic ring attached to the frame at the bottom until both valves are open simultaneously (this can be determined by touch) and running water through it.

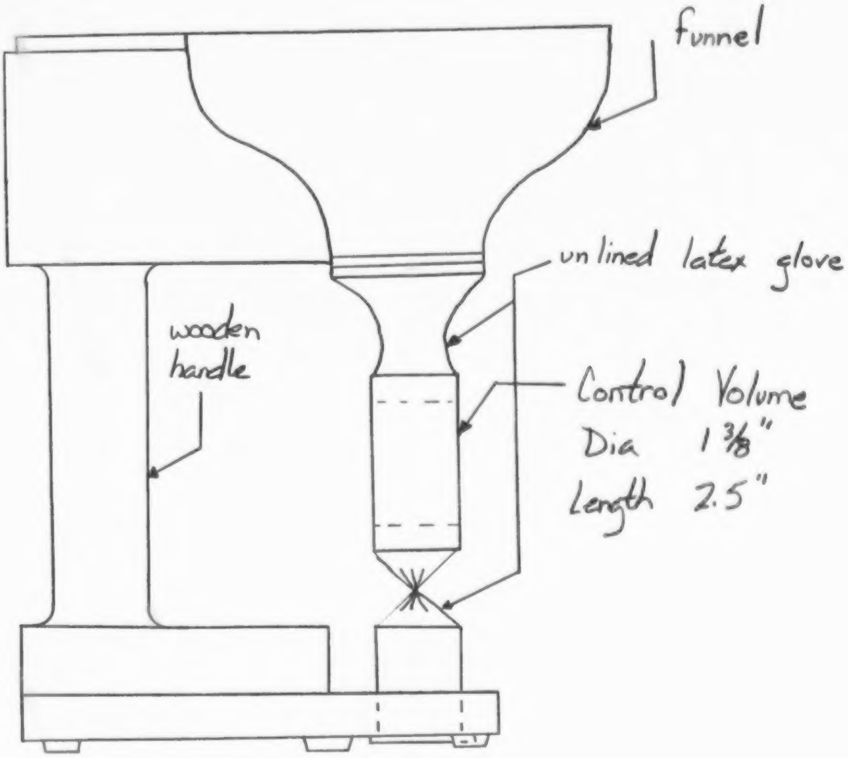
SUMMARY OF IMPACT

The client is this case is counselor of handicapped, particularly those with vision impairments and he himself is blind. There appears to be two difficulties with this device. The first is that it does not address a large need for the sight impaired. The second problem is that to use this device for its intended function is no easier and, perhaps, somewhat more cumbersome than to do it without using specialized means.

TECHNICAL DESCRIPTION

This measuring device has a wooden frame of which the handle is part. Attached to the top of the frame is a wide-mouth funnel and at the bottom of the frame coaxial with the funnel is a short length of rigid plastic tube. The plastic tube has a flange that prevents it being pulled up through a hole in the frame base. A longer length of the same rigid plastic tube constitutes the control volume in the measuring column. It is suspended between the lower opening of the funnel and the upper opening of the piece of plastic tube in the base by two elastomeric valves which resemble thick sausage casing. A suitable material for the valves has been difficult to find. Sections of fingers from unlined rubber gloves is the best material which has been found to date.

The approximate cost of making this device is about $15.



"Jar Opener"

Designers: D. Turnbull
Supervising Professor: R. A. Willem, Ph.D.
Mechanical Engineering Department
New Mexico State University
Las Cruces, NM 88003

INTRODUCTION

Jars with screw-on lids can be difficult to open, particularly for the elderly or others who due to injury have reduced upper body strength. The outcome of this project was the development of a device for opening jar lids.

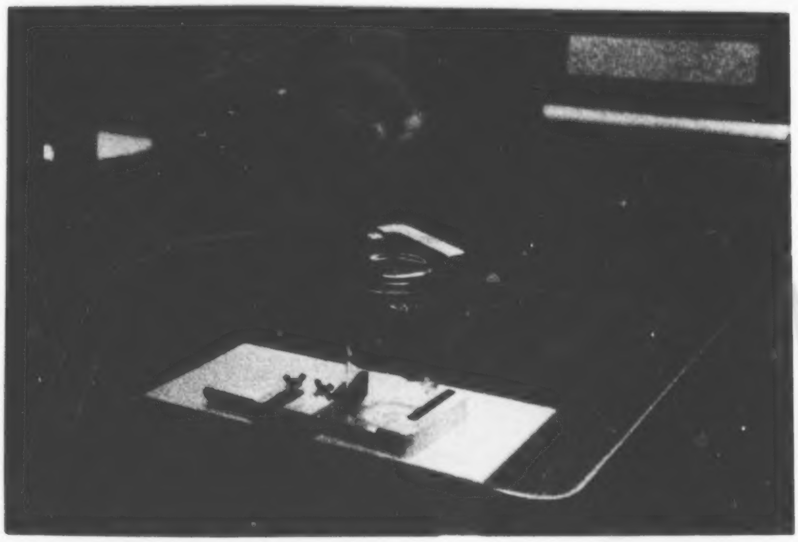
This device makes use of the same principle for gripping a jar and lid that is used in a pipe wrenches. To use it, a jar is set on the base and the jaws of the stationary gripping unit are adjusted to grip the jar in the vicinity of its bottom. Then the movable gripping unit is adjusted to grip the lid and then using the wood handles, a torque is applied to loosen the lid.

A feature of this device is that a very large torque can be applied to the lid with relative ease. The rubber inserts in the lower grip holds a glass jar well, however, the upper (movable) grip which has tooth inserts made of aluminum was found to slip in some instances on painted metal caps.

The base is designed so that it can be placed on the edge of a counter or table top and it can also be set in the lap of someone in a wheelchair (the semi-circular cutouts are intended to fit over the user's thighs).

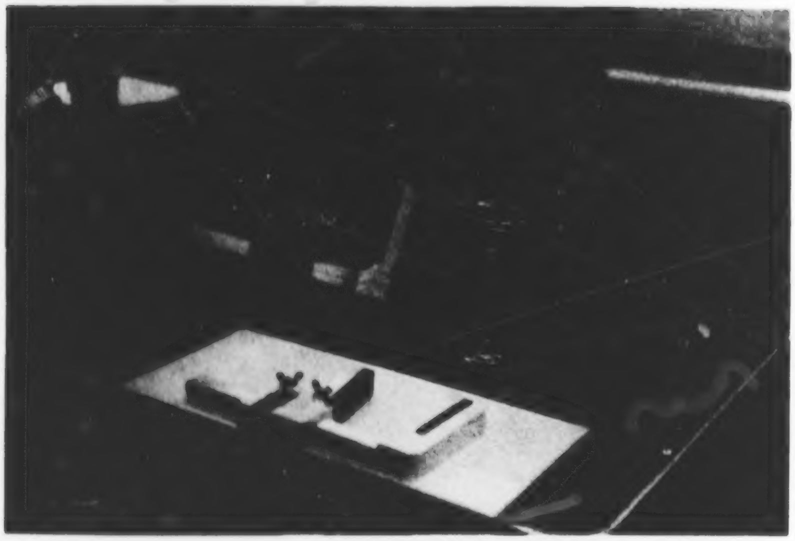
SUMMARY OF IMPACT

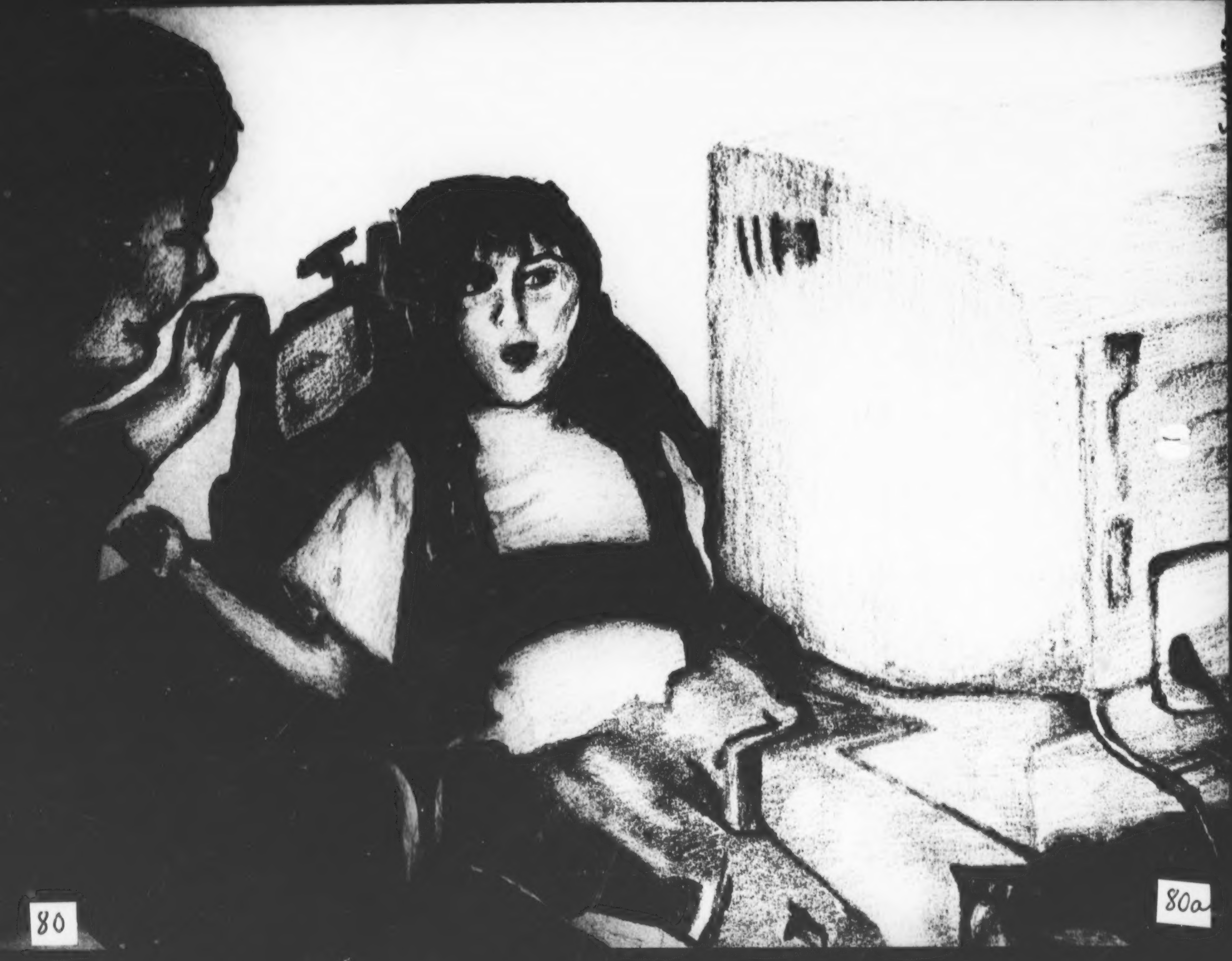
The client for this device is a frail elderly woman who lives alone. She makes occasional use of the device, however, it is somewhat large, hard to store, and expensive for its intended function.



TECHNICAL DESCRIPTION

The detail drawings describing this device were made in full detail. They are too large to be reduced to a single small page. That being the case, photographs are the best means of description. If there is further interest in this design, the designer can be contacted through the supervising professor. The cost of fabricating this device was approximately $750.

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CHAPTER 5

NORTH DAKOTA STATE UNIVERSITY
COLLEGE OF ENGINEERING & ARCHITECTURE
DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING
FARGO, NORTH DAKOTA 58105

Principal Investigators:

Daniel J. Krause (701) 237-7616

John D. Enderle (701) 237-7689

81

Emergency Telephoning Given Minimal Finger Strength and Dexterity

Designer: Megan Everett
Disabled Coordinator: Dr. S.F. Everett, M.D.
Supervising Professor: Dr. Daniel Krause
Electrical & Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

INTRODUCTION

There are many types and degrees of disabilities, such as severe arthritis, which make operating even a Touch-Tone phone difficult. In the extreme of an emergency a person may be completely unable to dial or go for help. This emergency dialing system design modifies a speaker phone, allowing the person to communicate the nature of the emergency even at a distance and even if unable to grasp the receiver or to dial. Three stored numbers can be called, each at the touch of a single large button. The 911 emergency number can also be accessed by a device small enough to fit easily in the palm of the hand. The 911 service would automatically direct help to the correct address. However, the real achievement of the system is that the person can explain the situation and be assured that the appropriate type of assistance is on its way. This is a vast improvement on the best system available now, which lets an operator know someone is in difficulty but not the nature of the problem.

SUMMARY OF IMPACT

The emergency dialing system was developed to respond to critical situations where the ill person was physically unable to move to the telephone. This prototype has been installed, tested and used in a home for nearly three months. The disabled person has been confined to a wheel chair for eleven years due to severe arthritis and weakness. The device has worked flawlessly.

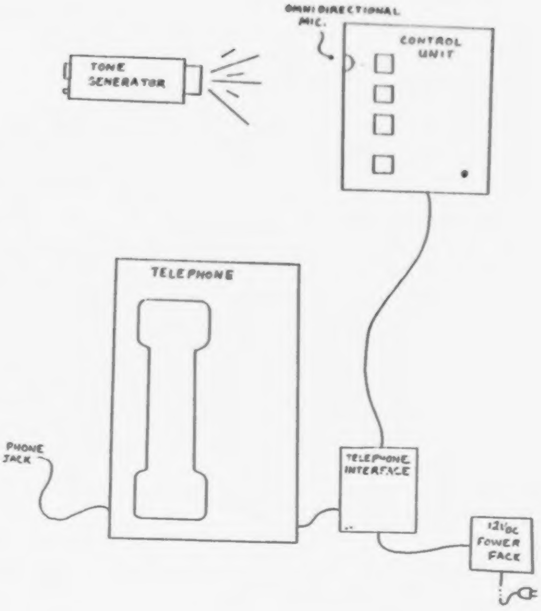
Thus far there have been no crises requiring she call 911. She finds it very helpful in calling frequently used telephone numbers, far superior to her previous telephones. She has been more confident and able to be more active, free from the fear of being unable to reach help shold she need it, due to the emergency telephone dialing system. This system has greatly improved the quality of her life, as it could those who are similarly handicapped.

TECHNICAL DESCRIPTION

The remote activation utilizes a tone generator and a monostable. It functions as long as the telephone is within "hearing distance," which is a farther distance than that over which the person's voice will carry due to the piercing nature of the tone. Were several of these devices installed the person would always be within speaking distance of help. A microphone channels the tone through a decoder. When it is recognized, a series of monostables signal the telephone to be taken off-hook and the number to be dialed. The switching automatically places it in speaker-phone mode though the telephone can be set for private operation during normal dialing.

This emergency dialing system is modular in design; making it very adaptable to variations, easy to understand and easy to fix should some part of it fail. It consists of five main parts: (1) the speaker phone, (2) the telephone interface, (3) the tone generator, (4) the power supply, and (5) the control unit -- which, in turn consists of: (a) the tone decoder, and (b) the dialing controls. The speaker phone originally has an alternate action switch, which is actually comprised of 4 switches. They are responsible for taking the telephone off-hook, and switching the microphone and speaker in the receiver to those in the body of the telephone. The battery-powered memory is already included in the telephone, making storing and accessing numbers easy and according to the instructions in the owner's manual. The design's 4-pole double-throw relay replaces the manual speaker switch, allowing the switches to be thrown electronically. Reed relays are directly connected to the priority call buttons for the same reason. The remote tone generator consists of a piezo buzzer, a transistor to drive it, a monostable multivibrator and 2 normally open momentary single-pole single-throw switches -- one to activate the device and one to reset it. It is important that this device is easily handheld, easy to activate but not to accidentally activate, and that is has a reset to prevent the call from being placed if it is accidentally triggered.

The total cost of the project including the telephone is $210.



"Light Talker"
A Sequential Visual Communication Device for the Speech Impaired

Designer: Andrew Beauchamp
Disabled Coordinator: Becky Walters, Fargo Public Schools
Supervising Professor : Dr. Daniel Krause
Electrical & Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

INTRODUCTION

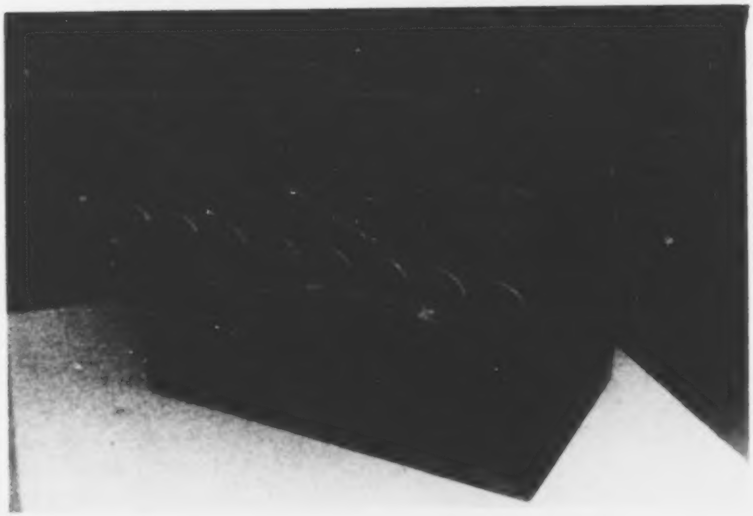
The Light Talker is a communication tool that can be used by speech impaired people to convey eight simple messages. Each message is located above a light. These eight lights form a horizontal line, with only one light on at a time. The lights are controlled using one of two modes. The primary mode "advances" one light with one press of the switch. The secondary mode "advances" continually at a variable rate with a single press of the switch. A second press of the switch stops the "advance".

The device will be used by a speech therapist to communicate with a speech impaired student. Commercially available communicating boards did not prove effective for this student.

SUMMARY OF IMPACT

A linear scanner was designed to facilitate expressive communication in a nonverbal child with severe handicaps. The child is nonambulatory, exhibiting limited mobility in the upper extremities. Visual acuity appears to be good, but visual functioning is inconsistent with difficulty controlling eye gaze and fixating for long periods of time. The child has a few meaningful vocalizations and uses an eye gaze board to make simple requests. Due to difficulty sustaining eye gaze, it is often difficult to judge which request the child is making.

The linear scanner gives the child another means of communicating basic needs and desires. The device is a stepping-stone to teach basic skills that will be needed in learning to operate a more sophisticated system. We no longer need to make a judgement as to what picture the child is gazing at since the light will indicate the child's choice. But most importantly, the student thoroughly enjoys using the equipment and is self-motivated to learn to use it efficiently.



TECHNICAL DESCRIPTION

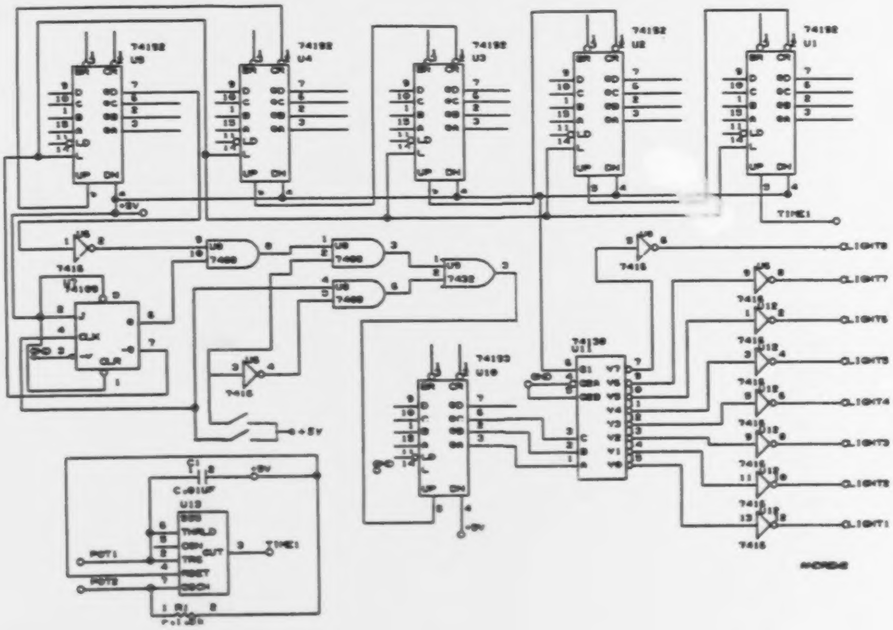
The box which contains the components is seven inches tall, eleven inches deep, and twenty inches long. The lights and pictures are located on the cover which can be secured at different angles. Since the school for the disabled students has a variety of custom switches that have a male 1/8" phono plug output, there is a female jack on the front of the Light Talker. The electronics, on/off switch, mode switch, and speed dial are located inside the box. A connector is located on the back of the box to attach to an external power supply which provides +5 volts and +12 volts.

The primary mode of this device is relatively simple to design. The switch which connects to the front of the box is debounced with a one shot that is set for 1/4 second pulse time. When the switch is pressed, it generates a leading edge to the input of divide-by-eight counter. The three low bits of the counter are then connected to a 3 x 8 decoder. Each of the lines from the decoder is connected to an inverter which drives a transistor. The transistor is either cutoff or saturated. Since there is an emitter resistor on the output of the inverter, no additional biasing resistors are used. The +12V line connects through a light to the collector of each transistor.

The secondary mode of operation is a little more complex. In order to accomplish the variable time delay, a 555 timer was used. Since the delay needed to vary between one and eight seconds, a variable feedback resistor and "divide-by 100,000" counter are implemented. The output of this system is a leading edge that can be used to trigger the primary system. In order to turn the secondary system on and off, a flip-flop that changes with every user switch input was added at the front end. If the flip-flop has a low logic level, Y. Then the inverted Y is connected to the reset lines of the "divide-by-100,000" counter. When the user switch triggers the change to a high logic level, the counter begins counting and the flip-flop generates the first leading edge. When the high bit of the last counter becomes high (it has reached 100,000), it drops the output to low for one count. When it resets (one pulse after 100,000), it generates a second leading edge. This process repeats itself until the user switch changes the flip-flop to a low logic level. this changes the output to low and resets the "divide by 100,000" counter.

A logic level from the "mode switch" is used to determine which mode is being used. The logic level is added with the user switch output; it is also inverted and added with the secondary system output. These two and-gates are connected, via an or-gate to the primary system input. This way, the primary system is protected from receiving two independently generated inputs.

The Light Talker cost one-hundred fifty dollars ($150) to build. Since there are a number of customized switches that use 1/8" plug, the Light Talker's mode of operation can be easily varied. The device can be used to help many different speech impaired people to communicate.



"Pneumatic Sewing Machine Speed Control"

Designer: Darin Westley
Disabled Coordinator: Susan McMahan, Fargo Public Schools
Supervising Professor: Dr. Daniel Krause
Electrical & Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

INTRODUCTION

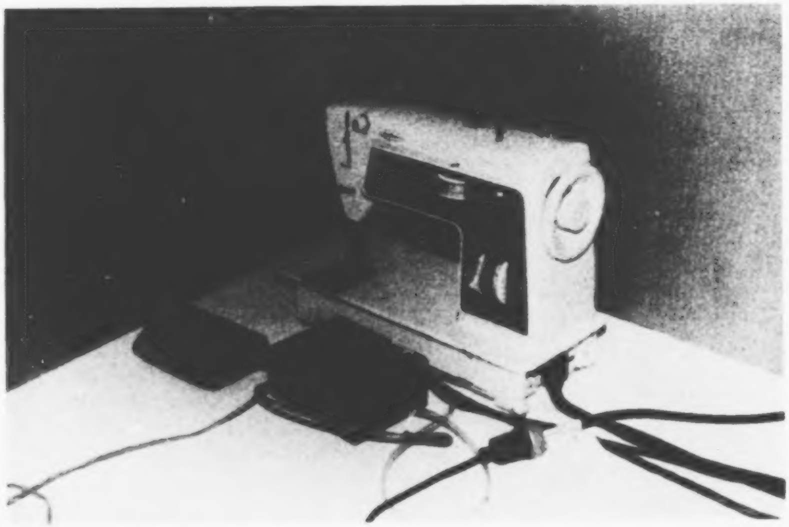
The purpose of this particular project was to develop an adaptation to a sewing machine speed control system to enable a handicapped individual to operate the machine with greater ease. The individual involved had cerebral palsy and was confined to a wheelchair. In order for her to operate the machine before the project was implemented, she had to place the foot pedal on the table and control it with her hand, which only freed one hand to sew with.

The basic idea behind this adaption was to utilize pressure to adjust the speed of the machine. This was done by using an air-filled tube, in which the operator could either bite down on, or place between her fingers and squeeze, to transmit pressure to a transducer. The varying input pressure would create varying voltage output levels from the transducer, which were used to supply a pulse-width modulating chip, which supplied the current drive for the sewing machine motor.

SUMMARY OF IMPACT

The sewing machine switch adaptation designed for a physically handicapped secondary student will be utilized to enhance her ability to participate in a recreational/leisure activity.

The student this adaptation was designed for, is considered educable mentally handicapped with cerebral palsy. The CP involves her upper and lower extremities which hinders her use of either a foot or thigh control when using a sewing machine. Due to her high interest in sewing, this adaptation allows her to be independent. This activity also helps her develop her eye/hand coordination and with practice will enhance her self concept and creativity.



TECHNICAL DESCRIPTION

The approach employed for this project was one which used pneumatic pressure to vary motor speed. An air filled tube was used to transmit pressure to a transducer, which in turn varied the output voltage. The circuit used was one which was modified from a MOTOROLA off-line motor control. The MOTOROLA circuit used a full wave rectified voltage dropped through a resistor to supply a plus width modulating chip that generated a variable voltage to control the motor's speed. The original circuit was designed to drive a 1/2 horsepower motor. For this reason it used a MOTOROLA SENSE FET which employed current mirroring techniques to prevent overdriving the fet.

For the particular application in this project, the motor drew at most one amp. Therefore mirroring was not needed. Instead, the pulse width modulating chip was used to drive the gate of a triac, with main terminal one connected to one leg of the motor, and main terminal two connected to common. The PWM IC (Motorola MC34060) furnished dead time control, soft start, error amplifiers, and double-pulse suppression. The soft start and overcurrent protection limit motor start up currents, which could otherwise be three to ten times the running current. The IC also suited switching-regulator systems with two error amplifiers. A 200 mA output transistor, and adjustable dead time control. Soft start was achieved through the dead time feature, while overcurrent protection used the error amplifiers.

Pulse-width control in the original circuit was achieved by applying a dc control from the potentiometer to the IC's comparator input (pin 3). With no resistance into pin 3 the full control voltage of 3.7 volts was applied, resulting in zero pulse-width and no motor rotation. With full resistance into pin 3, 1.6 volts gave maximum pulse-width and full motor speed. For the project's application, the HONEYWELL MICROSWITCH 164PC01D37 pressure transducer replaced the potentiometercircuit into pin 3. Since the circuit was designed to increase motor speed with a decrease in voltage applied to pin 3, the vacuum side of the transducer was used. The characteristics of the transducer, when using the vaccum side, were such that an increase in the input voltage would result in a decrease in output voltage. The supply voltage for the transducer was realized by a 7 K-ohm, 10 watt resistor and an 8.2 volt, 1 watt zener diode. A similar drive was used for the IC, with the exception of a 15 volt zener instead of 8.2 volts.

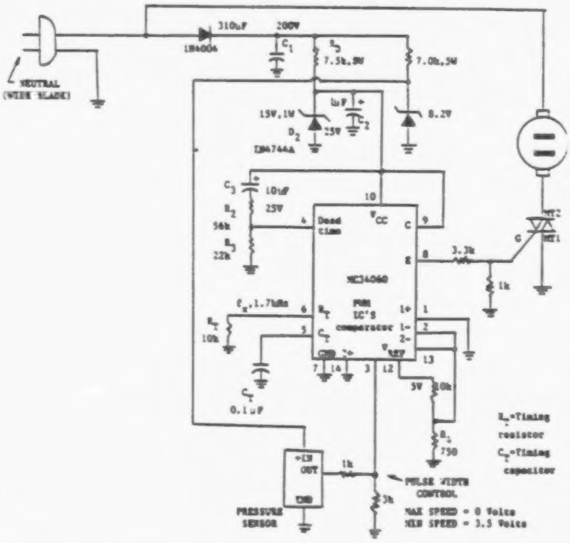
Another modification involved the input. Since a triac was used, the full wave bridge was removed, and a 400 volt diode was placed in series with the input line to the positive lead of the 200 volt capacitor.

The last change in the project circuit was due to the fact that mirroring techniques were not employed. The original circuit called for a mosfet which was a four terminal device. The fourth terminal was used for mirroring and was connected to an error amplifier (pin 1) in the comparator portion of the IC. Since mirroring was not used in the project, pin 1 was connected to common.

A female plug was used to connect to the existing foot pedal so that the pneumatic control could be disconnected and the sewing machine could be operated in its normal mode. When using the control, the foot pedal could be clamped down, effectively bypassing its control.

The air tube connected to the transducer has a rubber bladder on the one end which is the control. It can either be controlled using the operator's mouth to apply pressure, or it could be placed between two fingers and squeezed while sewing.

The cost of the components was $220. The pressure transducer, costing $160, was the most expensive component.



The Quad-Response Teaching Aid

Designer: Steve Vorderbruggen
Disabled Coordinator: Arloine Mithum, Fargo Public Schools
Supervising Professor: Dr. Daniel Krause
Electrical & Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

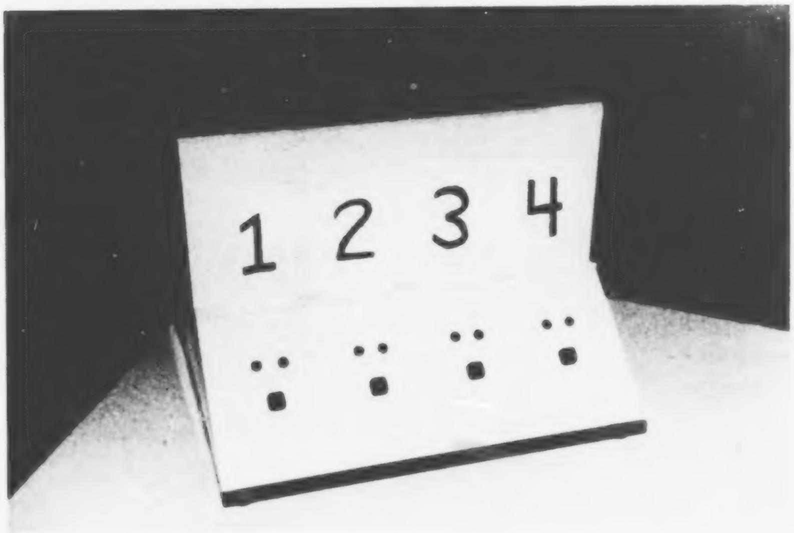
INTRODUCTION

This project was developed to aid in the education of young, mentally handicapped children. It is designed primarily to help students develop basic learning skills. It will be used by students to respond to a teachers verbal questions, using a multiple choice format. The device holds four pictures on a backboard, and four objects may be placed on a shelf above them. The student then makes his response by pressing the button in front of the item he chooses to be correct. When a button is pressed, the machine responds with audio and visual feedback consisting of a buzzer and colored light. Separate types of reinforcement are given for a correct or incorrect answer. This machine can be a powerful reinforcing aid, when combined with an instructor's encouragement.

SUMMARY OF IMPACT

The project was designed for one child who is subject to seizures, has a very short attention span and a developmental delay of over two years. He is able to sit up but needs a teacher or aide to work with him.

Using the machine, we could use 2 or 3 picture cards and the child was able to choose the correct picture bi pressing a button. He was interested in the green light for a correct response or red if he needed to try again. All of the children enjoyed using this project and it was very helpful for 2 of the children.

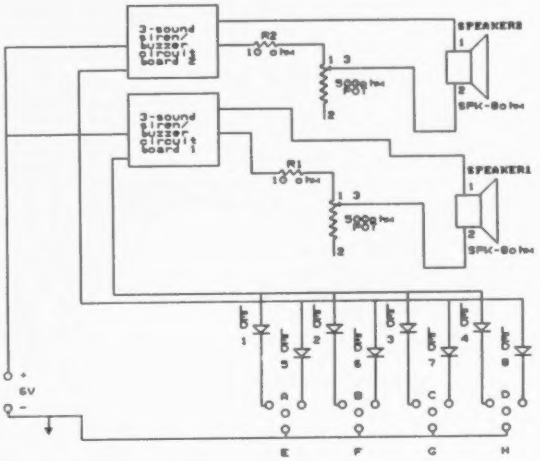


TECHNICAL DESCRIPTION

The Quad-Response Teaching Aid is a small console approximately 17" L x 12" H x 11" W. The backboard holds four 3" x 5" picture cards, while a small object may be placed on the shelf above each one. An answer button, red LED, and green LED, are located on a slight incline in front of each card. On the backside of the device are four switches which are used by the teacher to set the correct answer into the machine. The setting of each switch determines whether the picture or object it is behind is a correct or incorrect answer. Two sirens are located inside the backboard. One siren responds to a correct answer, while the other one responds to an incorrect answer. Each siren is controlled by a separate volume knob. This provides greater control over each buzzer's strength as a positive or negative reinforce. This device is powered by for "D" size batteries in series for a total of 6V. These are placed in the bottom of the machine, and are conserved because power is only used when an answer button is pressed. The machine should give well over seventy hours of use when operated with "D" cells rated for 1.1 Amp hours. The unit is designed for desk top use with the teacher close by. However, it is portable so that it may be used anywhere in a classroom. Although it is not weatherproof, it may be used outside on a table or bench. It should not be used in direct sunlight, as this makes it difficult to see the LED's.

The circuit for the Quad-Response Teaching Aid is mainly a series siren and LED combination powered by a six volt DC source. A volume control consisting of 500 ohm potentiometer in series with a ten ohm resistor are placed in series with the siren. The tri-sound siren, purchased from Radio Shack, contains a circuit board and speaker enclosed in a small case. This case was cracked open, and potentiometer and resistor combination were soldered in series with the speaker. It was found necessary to employ the ten ohm resistor to prevent the siren's malfunctioning at the highest volume setting. There are eight possible siren and led combinations, one correct and incorrect setting for each answer button. Depending on the setting of the switches in the back of the device, positive or negative reinforcement is received when an answer button is pressed. If the correct answer is chosen, for example, a pleasant siren sound will be heard and the green LED will light. However, if an incorrect answer is chosen, a slightly annoying siren is encountered, as well as a red LED. The unique case design of the Quad-Response Teaching Aid is what makes it so versatile and useful. It was constructed to specifications using white, 1/4" plexiglass. A removable bottom panel of 1/2" thick, clear plexiglass was attached using screws. This thickness adds a little extra weight which helps keep the device stationary during use. It also makes a very sturdy base which protects the device from falls. The bottom part only needs to be removed to replace the batteries in the holder attached to its inner surface. The front face of the case is slanted to allow for viewing of the LEDs and easy use of the answer buttons. The body of the Quad-Responder creates a wall which denies the student access to the setting switches and volume controls. The 1/2" picture shelf, running the length of the machine, is one of its most important features. It holds the 3" x 5" cards that are used to teach the children many useful concepts.

The cost of The Quad-Response Teaching Aid was $125.



Shape Identification and Placement Workshop

Designer: Danial C. Pillar
Disabled Coordinator: Sherry Johnson, Fargo Public Schools
Supervising Professor: Dr. Daniel Krause
Electrical & Electronics Engineering
North Dakota State University
Fargo, ND 58105

INTRODUCTION

The Shape Identification and Placement Workshop is designed to aid those handicapped persons who fall into the classification of "trainably mentally handicapped." (IQ=50) The workshop is composed of eight common geometric shapes that require the person to properly identify each shape and place it into the corresponding recession located on the face of the board. Positioning each shape into the recessions on the board produces a response of either a green light accompanied by a tone for proper placement or a red light accompanied by a different tone for an incorrect placement.

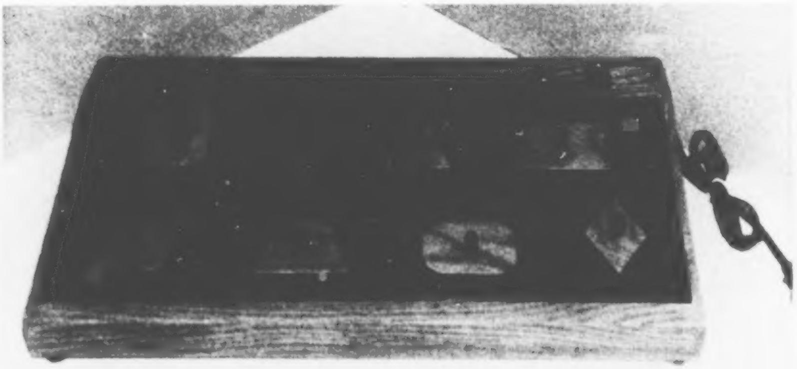
To be able to function in the "real world" the skill of identifying objects and being able to associate them with their proper resting place is a necessity. For the mentally handicapped person, this skill enables them to achieve a sense of self worth in knowing that they are able to perform tasks that are very important to everyday living.

SUMMARY OF IMPACT

The child is trainable mentally handicapped with no physical disabilities and a short attention span. The child needs activities lending themselves to opportunities to work at a task independently.

The shape and size sorter gives the child the opportunity to work with a fine motor task that provides immediate reinforcement either by a red or green light or a tone. The child knows immediately if their response is correct and if not to try another position on the board. The child adapts quickly to get the desired tone and green light which means a correct response. The knob on each shape makes it easier for the child to manipulate the pieces.

The device is a beginning way to give the child a chance to work independently and to operate various types of electronic equipment. The child is motivated to use the equipment because of the positive immediate feedback and the opportunity to work at a task independently.



TECHNICAL DESCRIPTION

The main structure of the electronics involved in the design utilizes TTL logic in determining whether proper placement of each shape has occurred. Within each 3/4 inch deep recession there are placed two small single pole double throw (SPDT) momentary lever type switches and one small subminiature push button momentary SPST switch. The lever switches located on the sides of the recession and the push button on the bottom, when all pressed together indicate the correct placement of a shape. Closure of the push button switch with any other combination of lever switch closures will indicate incorrect placement. For simplicity sake the path of logic involved to produce the response indicating correct placement will be presented first and will then be followed by that of an incorrect placement.

To first clarify the operation of the logic gates used within the design it is desirable to know how the logic levels are obtained. To impose the state of logical zero on the chain of logic gates 1 kOhm resistors are tied directly to ground on the 74LS08 side of the switches. When the momentary switches are in the open position the path of the inputs to the logical gates will be directly to ground through the resistors. When the switches are closed, however, a five volt supply from a JE-210 5v DC power supply is applied to the inputs of the 74LS08's imposing a high state of "logical one".

Correct placement occurs when all three switches within a recession are closed. Each set of the two lever switches within the recession connect directly to quad two input AND gates (74LS08) whose outputs connect to one input on each two input NAND gate aboard a quad two input NAND gate (74LS00). At the 74LS00, the push button switch joins the operation as the second input corresponding directly with the output of the two lever switches it shares a recession with. Eight such NAND gates referring to the eight shapes are then tied into a dual four input AND gate (74LS21) and continue by connecting as the inputs to a two input AND gate contained on a 74LS08 chip. It is at this point in the logic chain that indication of correct placement may be seen. Correct placement will close the two side lever switches as well as the push button switch sending five volt signals to both the 74LS08 and the 74LS00 chips. The 74LS00 being a NAND function will then send logical zero signals to the 74LS21 chip which in turn will produce logical zeros as outputs. These logical zero outputs invoke a zero output from the last set of 74LS08s causing a drop from an original condition of high (approximately 5v) that occurs in the preplacement state. Because the push button switch is momentary and spring controlled the original state of high is returned to once the shape has been placed. The dip in the output signal is what then controls the remainder of the circuit. A complete explanation of that operation will follow that of the incorrect placement discussion.

Incorrect placement uses the same type of logic as that of correct placement with the addition of an inverting gate (74LS04) on the output of the first bank of quad dual input ANDs. The outputs of the inverters then connect with the push button inputs at a separate set of 74LS00 NAND gates, 74LS21 AND gates and finally the 74LS08 AND gate. Incorrect placement will cause the correct placement circuit to experience no change on the output. The incorrect circuit, on the other hand, will see the same type of output as shown in the earlier figure.

The outputs indicated above are then both connected to a 556 timer network. Although the 556 is a timer IC, the Workshop utilizes it to produce a monostable output through the use of external connections and components. Working on a trailing edge of the input signal as shown in the previous figure, the 556 produces output pulses, at pins five and nine, whose length is determined by the designer. The outputs of the 556 timer, one being the signal for correct placement and the other incorrect are connected to the base of a 2N222A transistor and the gate of a JFET respectively. The source of the JFET ties to the ground through a current limiting resistor which acts as the driver for the base of the NPN transistor. The NPN then has its emitter tied directly to ground and the collector is connected to the buzzer and light which is in turn connected to a five volt power supply.

The transistor-transistor driver likewise drives the second transistor through a 1 kOhm current limiting resistor connecting to the second transistor in the same fashion as described above. Operation of the light and buzzer occur when the monostable signal is emitted from the 556. That signal turns the JFET and the NPN transistor on which then ties the base of the second NPN to 5 volts which in turn causes the NPN to turn on and complete the circuit for the light and buzzer. The same connections are made for both correct placement as well as for incorrect placement.

The cost of the components was $120.

An Ultrasonic Ranging System for the Visually Impaired

Designer: Eric Durfee
Disabled Contact: Bret Person, NDSU Student
Supervising Professor: Dr. Daniel Krause
Electrical & Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

INTRODUCTION

The Ultrasonic Ranging System is a navigational and obstacle aid for visually impaired people. The device transmits an ultrasonic tone burst and the time it takes for the echo to return is used to generate an audio tone with a frequency proportional to the distance to the object. It has an adjustable tone range, a resolution of .58 feet per tone, and is packaged in a single hand-held box with headphones and a volume control for the audio tone.

The ranging system will detect solid objects, people, and even curbs. Doorways can be easily found.

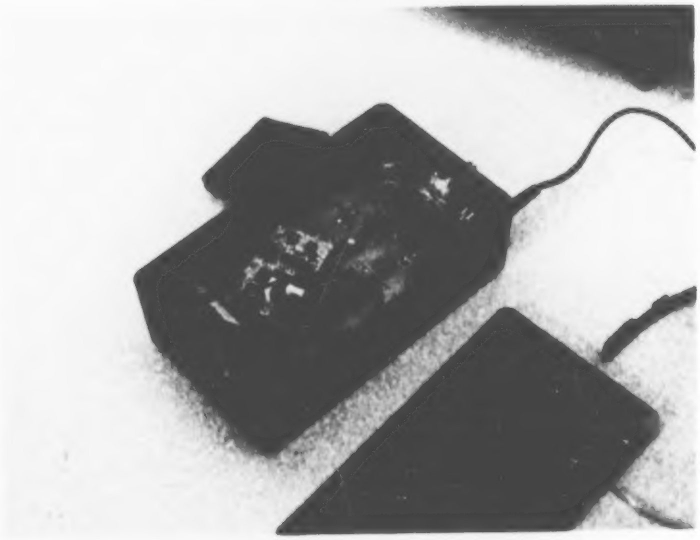
SUMMARY OF IMPACT

I found the sonic cane to be an excellent device for the blind. It is a far better alternative to the standard long white cane because it is capable of detecting objects that the white cane would miss entirely. Objects which are above the waist of the blind person are not well-detected by the white cane, this can lead to some serious injuries.

The sonic cane performs above and beyond my expectations for the device. There are no readily apparent problems when using it. I like the fact that it detects low-hanging tree branches and objects that could be potentially harmful when in the path of a blind person

The size of the unit should be reduced, and there should probably be some other method besides the constant beeping as a warning signal. The beeping tends to become annoying and distracting after awhile.

Overall, I feel that the cane is an excellent first attempt. A very usable device.



TECHNICAL DESCRIPTION

The ultrasonic ranging system is housed on a box that measures 7.5x4.25x25 inches. It has a pair of mini-headphones and volume control for the audio output and a power switch for the entire system. It is powered by four AA batteries and one 9 volt battery contained within the box.

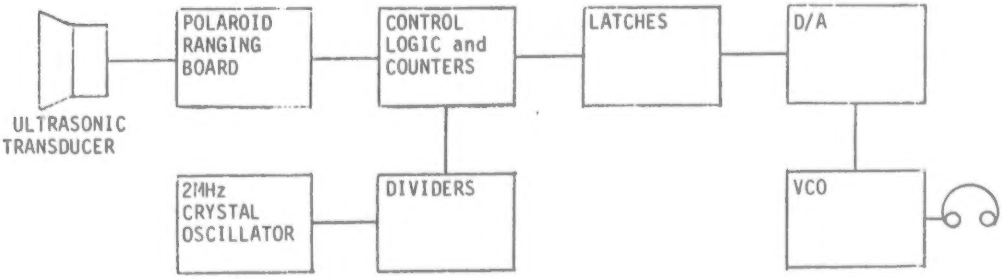
The circuit can be broken down into two major parts. The first is the distance-to-time (D-to-T) converter which measures the distance to an object and has as an output a time between two signals that corresponds to the distance. The second part is a time-to-frequency (T-to-F) converter which measures the time between the signals and converts it to a corresponding audio tone for the user.

The more difficult job of D-to-T conversion is handled by the Polaroid Ranging Board (PRB) and the Polaroid Ultrasonic Transducer (UST). When a start signal, called VSW by Polaroid, is given to the PRB, it generates a 1ms tone burst at a frequency of 49.41KHz and a signal, XLG, indicating that the transmission has occurred. The UST transmits the tone burst and is then used as the microphone for the returning echo. When the first echo is received, PRB generates a pulse on a line called FLG to indicate it has received an echo. The time between the leading edge of XLG and the leading edge of FLG is the desired output.

The T-to-F conversion, although easier than the D-to-T conversion, was where most of the design time was spent since it does not come as a prefabricated device. The control logic portion of this circuit generates the VSW, then it uses XLG and FLG to generate three signals for the counters and the latches. The dividers generate two signals from the 2MHz crystal oscillator, CLK1 and CKLK2. The counters are used to count pulses from CLK1 during the time interval between XLG and FLg. An object farther away will have a longer time interval and will cause a larger number of pulses to be counted than a nearer object. The latches save this count for use by the tone generation circuit.

The tone generator consists of a digital-to-analog (D/A) converter, a voltage control oscillator (VCO), an op amp and a power amp. The count stored in the latches is fed to the D/A which gives an output voltage that is proportional to the count. This output is level-shifted by an op amp and then used as the control voltage for the VCO. The VCO output frequency is then directly proportional to the distance to the object detected. After power amplification and filtering, this frequency is fed to a pair of headphones for the user.

The cost of components was $145.



OBJECT RECOGNIZER

Designer: George O'Connor
Disabled Coordinator: Jean Sanner, Fargo Public Schools
Supervising Professor: Dr. Daniel Krause
Electrical & Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

INTRODUCTION

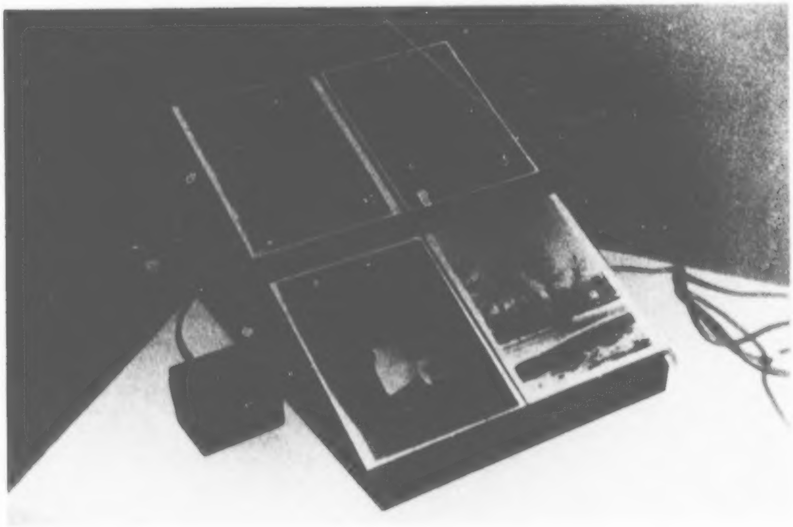
The "Object Recognizer" was designed to assist the instructors at an elementary school for teaching the learning disabled. The idea came directly form an instructor. The device is quite versatile since it can hold up to and including 4 8" x10" pictures or cards. The teacher chooses which slot contains the correct picture by pressing the corresponding button on the control box. The child makes his/her choice by pressing the button directly beneath the picture. Reinforcement is both visual and auditory for both positive and negative cases.

SUMMARY OF IMPACT

The device constructed was designed to reinforce a student for correctly identifying a specific picture. It could also be used for making a desired choice between 4 pictures. As designed, a picture could be inserted in each of the 4 openings from the schools language stimulation kits.

The idea of being able to alternate reinforcement between 4 locations is very important and this aspect of the project was excellent. The size of the picture slots was also very practical. The use of both visual and auditory reinforcement was potentially very helpful.

There were a number of problems in the finished product. The sounds produced for both "correct" and "incorrect" choices would be difficult for children to distinguish. The use of only a "correct" response sound would be better. Since the switches and reinforcing lights are below each picture, the child might not understand whether the switches between the pictures refer to the pictures above or below them.



TECHNICAL DESCRIPTION

The "Object Recognizer" consists of four clear slots each of which can house a picture as large as 8" x 10". The four slots are situated in a stacked manner, that is, two slots on top and two slots on the bottom. These slots will set at an angle to the table top. The openings to the slots will overlap the main unit by 1/2 inch. This will allow easy installation and removal of the pictures. Beneath each slot is a push-button switch to allow the student to choose which picture he/she believes to be correct. Along the middle are 8 indicator lights to act as visual reinforcement, both positive and negative. It should be noted that this device utilizes pictures of objects that the school has on hand (the largest cards that the school uses are 8" x 10").

The "Object Recognizer" also has a control box. The control box is connected to the main unit by a 6' cable. The control box will be hand held by the instructor. It consists of five buttons labeled 1, 2, 3, 4, and Reset respectively. This allows the instructor to choose which slot contains the correct picture. Once the student makes his/her choice the teacher resets the unit and starts over. The control box can be held so that the teacher can choose the picture without the students knowledge.

When the device is powered up and the red LEDs will flash and the negative siren will sound indicating that the device is ready for operation. The instructor must first load the slots with the pictures or flash cards of his/her choice. As mentioned earlier the unit can handle a maximum of four pictures or cards at any one time. Using the control box supplied with the unit the instructor chooses which slot contains the correct picture by pressing the button on the control box corresponding to that slot. The student then trys to choose the correct picture by pressing the large button directly beneath that picture. If the student's choice is incorrect, he/she will receive negative reinforcement through flashing red LEDs and a negative siren. The student can still try to choose the correct picture and can continue to do so until the correct picture is chosen or the teacher resets the device. If the student's choice is correct he/she will receive positive reinforcement through alternatelyflashing amber and green LEDs and a positive siren. The device is reset by pressing the "Reset" button on the control box. Once the device is rest the instructor can again choose which slot contains the correct picture.

For the teacher to choose the correct picture, there are four switches on the control box that correspond to the four pictures on the main unit. The control box is connected to the main unit via a six foot conductor cable. These switches are single-pole single-throw. One side of the switch is tied to ground, the other side goes to an invertor and is pulled high through a 1k ohm resistor. The other side of the invertor goes directly to a D-type flip-flop which is set up as a latch by typing the compliment output to the preset. This allows the teacher to only have to push the button once for his/her choice. The student's button that corresponds to the teacher's button is ANDed directly with the output of the latch to determine if the student chose the same picture as the teacher. The student presses the button directly beneath the picture of his/her choice. These switches are also single-pole double-throw switches and like wise have the one side grounded and the other tied high through a 1k ohm resistor and also connected to an input of an invertor. The output of the invertor is connected to an AND gate with the output of the latch of the corresponding button as the other input. It is also connected to a NOR gate with all the other student buttons which are used to trigger the 555 timer. The outputs of the 4 AND gates are NORed and then inverted. The output of the invertor is the input to a D-type flip-flop which is set up like a latch.

The output of this latch is connected to 4 NAND gates and 1 AND gate. The other input of the AND gate comes from a Decade counter used to divide the base frequency (1MHz) to approximately 2Hz. The output of the AND gate is connected to D-Type Flip-flop. This causes the output to toggle high and low at a frequency of 2Hz when a correct response is given. The output and the compliment are then connected to the 4NAND gates alternately which are in turn connected to the yellow and green LEDs respectively. This causes the green and yellow LEDs to alternate being on and off.

The compliment of this latch is used to control one of the relays that controls the siren, giving the positive sire. It is also ANDed with the output of another AND gate whose inputs consist of the output of the 555 timer and the output of the NOR gate. The output of the AND gate is inverted and is connected to the ground pin of the 4 LM3909 LED flashers which are used to flash the red LEDs for the negative reinforcement. The output of the 555 time is connected to an AND gate whose other input is the OR of all the latch output from the control box. The output of this AND gate is connected to the reset of the latch enables the yellow and green LEDs. The 555 timer output is also inverted and used to control the relay that enables the siren.

The components, including the fabrication of the case cost $135.

Writing Skills Improvement Board

Designer: Charles Breid
Disabled Coordinator: Karen Gertz, Fargo Public Schools
Supervising Professors: Dr. Daniel Krause and Jenny Rawson
Electrical & Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

INTRODUCTION

The Writing Skills Improvement Board is a device that will help handicapped students improve their writing skills. When handicapped children are learning to write, they have a tendency to wander all over the paper. The Writing Skills Improvement Board gives the students a warning when they are writing outside of the lines. The students will learn to write inside of the lines from using this board. The student needs only to place a piece of paper on this device, turn it on, and start writing.

SUMMARY OF IMPACT

This adaptation is designed for students with a sensory motor dysfunction and, visual/perceptual problems. It gives the student automatic feedback when performing a written task. Students with visual planning problems have difficulty perceiving when writing, their word formation is either too large or too small. The buzzer and the light will give the student both a visual and auditory cue. Immediate feedback is the best way to reinforce correct response and motivate the user to continue practice. Eventually it would be anticipated that repeated use of the board would improve the student's eye/hand coordination, gross/fine motor skills, handwriting skills, develop propioceptive memory, and re-education of motor skills.

TECHNICAL DESCRIPTION

The writing board is 15 inches long, 11 inches wide, and 2 1/4 inches tall and is made out of 1/4 inch plexi-glass. The top side contains a 7 inch by 12 inch opening into which the paper is placed. A sheet of plexi-glass is mounted under this opening and the paper is placed on this. Mounted to the top is the on/off switch, a power-on indicator, the warning buzzer and the warning light. Mounted on the back is a power jack that a 9 volt AC to DC adapter plugs into.

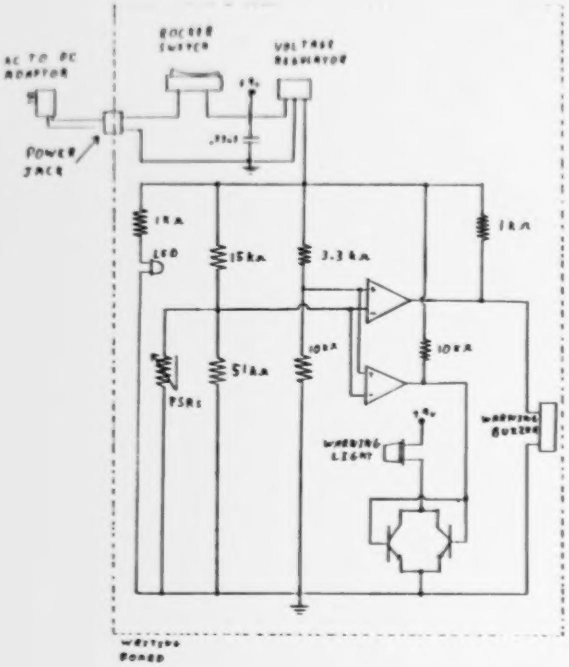
To sense pressure between the lines, Force Sensing Resistors (FSR) are used. The FSR is a device that can sense pressure. When pressure is applied to the FSR, its resistance decreases. This decrease in resistance is then converted to a voltage level by placing the FSRs in parallel with a 51k ohm resistor. This combination is then used in a voltage divider network with a 15k ohm resistor and a +5 volt source that is obtained from a 5 volt voltage regulator.

The voltage across the combination of the FSRs and the 51k ohm resistor is around 3.86 volts when no pressure is being applied. When a pencil is pressing on the FSR, this voltage drops to around 3.60 volts. A constant threshold voltage is compared to this variable voltage to determine if pressure is being applied to the FSRs. A threshold voltage of 3.75 volts is used and it is obtained from a voltage divider using a 3.3k ohm and a 10k ohm resistor and the +5 volt source.

These two voltage levels are compared using a comparator and when the voltage across the FSRs falls below the threshold voltage, the comparator output goes high indicating that pressure is being applied to the FSR and that a warning should be issued. To issue the warning, the buzzer is sounded and the light illuminated. Two comparators are used, one to drive the buzzer and one to drive the light.

The buzzer is connected from the output of the comparator to ground. A 1k ohm resistor is connected from the +5 volt source to the comparator output to provide the current to drive the buzzer. By varying this resistor, the loudness of the buzzer can be adjusted. The light is connected from the +9 volt source to the collectors of two transistors. The bases of these transistors are connected to the comparator output and their emitters are connected to ground. A 10k ohm resistor is connected from the +5 volt source to the comparator output to provide the current to drive the transistors. The transistors act as a switch to turn the light on and off. Two transistors are used in parallel so that enough current flows through the light such that it is illuminated bright enough.

The Writing Skills Improvement Board cost about three-hundred fifty dollars ($350) to build. Since most students will be able to use it, the teacher will find it to be a very useful device in teaching handicapped children to write.



CHAPTER 6

RENSSELAER POLYTECHNIC INSTITUTE
DEPARTMENT OF BIOMEDICAL ENGINEERING
TROY, NEW YORK 12180-3590

Principal Investigators:

J. Lawrence Katz (518) 276-6290

David G. Gisser (518) 276-6083

"Bar-Code Reader"
A Moving Bar-Code Reader for the Functionally Impaired

Designers: Peter S. Donzelli, James Carollo, Tony Chan
Disabled Coordinator: Beverly Maszdzen, Albany CP Center for the Disabled
Supervising Professors: Dr. J. Lawrence Katz and Dr. Jonathan C. Newell
Department of Biomedical Engineering
Rensselaer Polytechnic Institute
Troy, NY 12180

INTRODUCTION

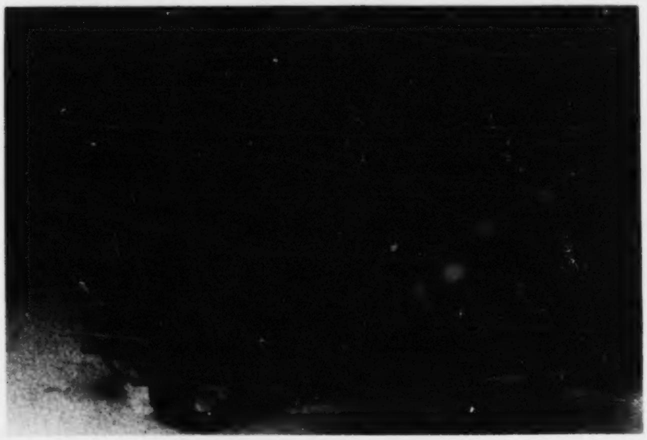
Many of the clients at the Albany Cerebral Palsy Center for the Disabled are non-verbal. Staff feel that a client would benefit from a communication system that provides audio feedback. The Texas Instruments Magic Wand Speaking Reader uses bar codes, a fiberoptic pen and an audio speaker to synthesize speech. However, the client does not have the muscle control to operate the Magic Wand. This device operates on the premise that the pen remains stationary and the bar codes are moved. The bar codes are on a sheet of continuous paper wound on wooden rollers. A toggle switch moves the codes left and right. While the toggle is active, no signal is sent to the speaker. A separate button is used to "speak" a code.

SUMMARY OF IMPACT

Many commercial devices exist which enable disabled people to communicate through synthesized speech. One such device is called the "Magic Wand". Ths device generates speech which is encoded in a series of bar-codes. To cause the device to say a word, the user must pass a bar-code wand over the appropriate bar-code. This device produces a high quality speech output and is used extensively to make talking language boards for non-speaking disabled people.

Many disabled people are physically unable to pass the wand over the appropriate bar-codes. A modification to the "Magic Wand" has been under development to enable a disabled person with diminished fine motor ability to use the Wand. The modification is designed to allow the user to move the bar-codes under a stationary wand. The user will increment the bar-codes with associated pictures and words by pressing a button. When the appropriate item is under the wand, the user will press another button to activate the wand and cause the device to speak.

The device is currently non-functional. The modification project was completed but was not tested by the time the school term ended, and the students involved in the design are no longer available. Further testing and work on the project has been given a low priority at this time due to a revised evaluation of client needs. Failure to complete the testing was due in part to a project change in the middle of the semester and the over-ambitious nature of the project.



TECHNICAL DESCRIPTION

This project entails adapting a Texas Instruments Magic Wand Speaking Reader. The device uses an optical bar-code scanner to convert bar codes to audible speech. The basis of the design is that the pen is fixed and the paper containing bar codes moves. This device was designed and constructed in three parts: the chassis, the mechanical systems and the control circuits. Plexiglas 1/4" thick was cut to make a box with inside dimensions 4" x 10" x 16". K-lax solvent for cementing was used for securing various Plexiglas components to one another. Bearings were cut from 3/8" Plexiglas and attached perpendicularly to the base with fine screws.

For paper take-up a spring-belt was used to provide both friction and slip. A 1.5" grooved Plexiglas wheel was attached to each of the paper rollers. A 3" Plexiglas wheel was placed between the two smaller wheels, and a spring-belt was looped around the three wheels. The larger wheel is driven by one of the 25 rpm reversible DC gearmotors, always in a single direction, whenever a switch on the device is activated. This motion of the large wheel drives the smaller wheels so that paper is always being wound onto the rollers. When the paper-drive system is activated and paper is being drawn off one roller, the spring-belt allows the wheel on this roller to slip while winding paper onto the other roll.

The 1/4" steel rods were cut to 9" lengths and fitted with ten rubber O-rings. These are the drive rollers. Paper is sandwiched between the drive rollers and 1/2" strips of 1/4" plexiglas attached to the lid of the chassis. Attached to each drive roller is a 2" pulley; these pulleys are connected by a 16" long V-belt. A 1" pulley is placed on one of the drive rollers and connected via a 12" V-belt to a 2" pulley on the shaft of the gearmotor. Thus, the motor drives one roller, which in turn drives the opposite roller, both at a linear speed of 58.9 in. per minute.

A toggle switch is used to control the direction of paper advancement. A push switch is used to scan a particular code. Both of these are connected to the Scantech with 1/8" RCA jacks. The signal from the toggle is not ideal, so a dual JK flip-flop is used to debounce the signal. Whenever a switch is operated, a low signal is sent to a 555 timer.

For proper action on the paper-drive system, the motors run for six seconds in order that one bar code passes the pen. The 555 timer produces this time constant. High output from the timer has two functions. An inverter takes the high signal and feeds it to the clocks of the JK flip-flops, insuring no other inputs trigger the timer until the six-second period has elapsed. Secondly, the high signal turns on the motors. Relays reverse the polarity of the source voltage for the motor, reversing the direction of rotation.

When the toggle switch is pushed left or right, output from the flip-flop will be sent to prevent signals from reaching the speaker. Four D-cell batteries are needed to power the Magic Wand. Each of the motors runs on three volts.

Cost of parts and construction was two hundred one dollars ($201).

Further details can be obtained from the principal investigator.

"The Mechanical Rocking System"
A Motorized Rocking Chair for the Functionally Impaired Child

Designers: Dawn Tramaglini, Miriam Lane, Marietta Malik
Disabled Coordinator: Beverly Maszdzen, Albany CP Center for the Disabled
Supervising Professors: Dr. J. Lawrence Katz and Dr. Jonathan C. Newell
Department of Biomedical Engineering
Rensselaer Polytechnic Institute
Troy, NY 12180

INTRODUCTION

This project entailed designing a mechanical system to set a rocking chair in motion. The system was designed to accommodate the needs of young children at the Cerebral Palsy Center for the Disabled in Albany, New York. These children exhibit poor trunk control, no lower extremity usage, and developmental delay. This system will allow the children to have a greater impact on their environment and aid in their understanding of cause and effect relationships.

The mechanical rocking system is powered by a low-horsepower motor and rocks at a speed of six rocks per minute. The chair is covered with cushions for comfort and is equipped with a seat belt for safety. The system is also easily mobile and requires little maintenance.

SUMMARY OF IMPACT

For many multi-handicapped children, the ability to control their environment is of prime importance in their educational programming. Many such children, due to their physical impairments, are unable to move themselves in space. Often this inability to move independently prevents full sensory integration. Most often, staff must attempt to provide those motor and sensory experiences for the child. While rocking in a rocking chair is a pleasant and motivating experience for normal children, multi-handicapped children may be unable to rock, due to orthopedic impairments and inadequate trunk control. These same children may be of a chronological age such that it is inappropriate for staff to hold and rock them in a chair. In addition, this type of activity would not provide the important aspect of independent control. Some of these children have not as yet acquired the cause-effect relationship through activation of simple toys. The motorized rocking chair allows for the positioning of a variety of children in a therapeutic manner. It also allows the child to activate the rocker for a pre-set amount of time, through the use of a commercial switch interface-timer box. This mechanical rocking system allows the children to have a greater impact on their environment and provides them with enjoyable recreational experiences. It remains a valuable educational tool.

TECHNICAL DESCRIPTION

A mechanical system to set a rocking chair in motion has been designed to accommodate the needs of young children at the Cerebral Palsy Center for the Disabled in Albany, New York.

The mechanical rocking system consists of five components: the rocking chair, the platform, the cushions, the motor, and the cam-follower system. The rocking chair is made from beechwood and is extremely large to accommodate the different tumble-form safety chairs that are used at the Cerebral Palsy Center. A seat extension was built from 3/8" plywood and attached to the chair with wood screws. It was shaped to cover the seat of the rocker and extends eight inches past the end of the chair. The seat extension is needed to accommodate children who have locked knees. For safety purposes a two-inch seat belt is attached to the side supports of the chair. Due to the odd shape of the chair, cushions for the seat, chair back and arm rests had to be custom-sewn. These cushions were made from heavy-duty vinyl because it was required that they be waterproof.

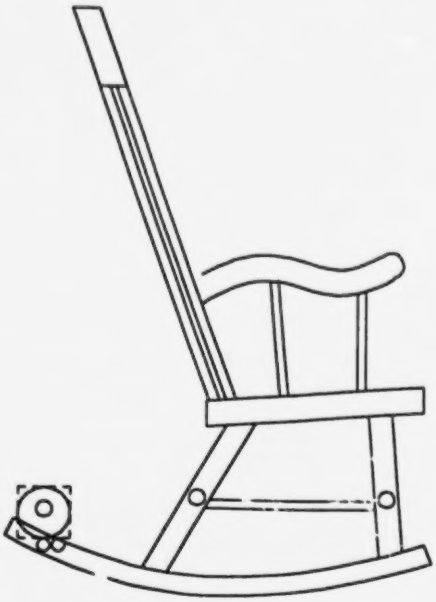
A platform for the chair and cam-follower system and an enclosure for the motor were constructed from 3/4" BC exterior pine plywood. The platform is 26" x 46" and has rounded corners for safety. To guard against side motion of the chair, a runner system is in place on both sides of the chair rocker arms. To permit easy mobility of the system, four caster-lock wheels are attached to the bottom of the platform.

The chair is powered by a constant torque, fan-cooled, shaded-pole, parallel shaft gearmotor (model #3M126). It produces a speed of six rpm, is safe for a torque of 113"-lb, has a horsepower of 1/20, runs with an amperage of 1.4, and has a 5/8" shaft diameter with a keyway. The motor is wired so that it can be powered from a standard wall outlet and a 2-amp sloblo fuse is in the system to compensate for the voltage surge that occurs when the motor is turned on.

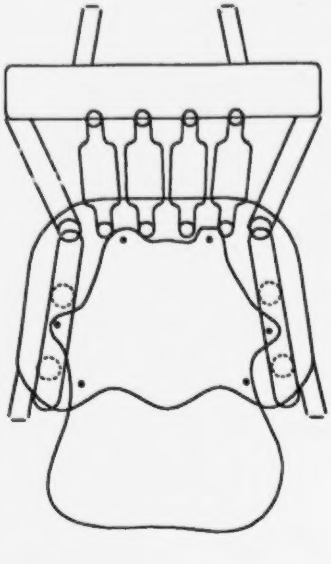
The cam system consists of a 5 1/2" pulley and a set-screw clamp welded together. The clamp was welded 1 3/4" from the center of the pulley. This offset gives a 2 1/2" displacement of the rocking chair. Two garage door rollers are used as the followers for the cam. The rollers are positioned on one of the rocker arms, one 1" from the end of the rocker arm and the other 3 1/4" from the end of the rocker arm. These distances provide a 1/4" space between the rollers. For added support, a block of 3/4" plywood is attached to the inside of the rocker arm. The motor was placed three inches above the platform and the cam rides over the 1/4" gap between the rollers. As the cam turns, it pushes the rollers with a vertical force that causes the chair to rock. To produce a positive-drive condition there is a spring connection from the pulley to the rollers. This spring prevents slippage and vibration between the cam and the followers.

The cost of parts and construction of this system was four hundred fifty five dollars ($455).

Further details can be obtained from the principal investigator.



Cam and Follower Design



Seat Extension Design

"Sit-n-Spin"
A Device to Provide Vestibular Stimulation for the Developmentally Disabled

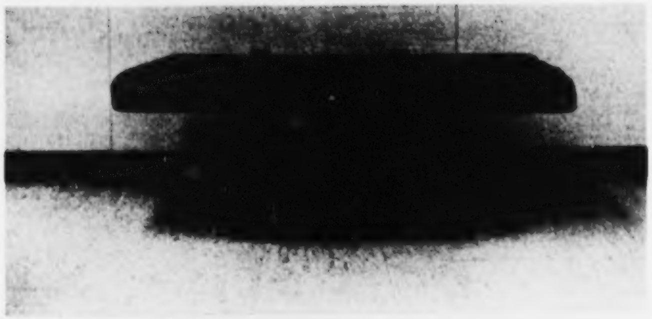
Designers: Michelle Gamble, Ray Chow, Mary Yoshimoto
Disabled Coordinator: Beverly Maszdzen, Albany CP Center for the Disabled
Supervising Professors: Dr. J. Lawrence Katz and Dr. Jonathan C. Newell
Department of Biomedical Engineering
Rensselaer Polytechnic Instituter
Troy, NY 12180

INTRODUCTION

The Sit-n-Spin design consists of a rectangular platform that is driven by a motor. A steel rod attached to its underside passes through a box which houses the motor mechanism and acts as a support system. The rotating platform rides on swivel casters that are attached to the top of the support box. The locking casters on the bottom of the box allow for transport of the device. The Sit-n-Spin was intended for use with the "Tumbleform Units" that are currently in use at the Center for the Disabled. The units are placed and held by the VELCRO on the platform. These units, along with the safety belts attached to the platform, allow the client to be held securely and comfortably in various positions. The client can control the device by pressing the remote control switch.

SUMMARY OF IMPACT

Many children who are developmentally disabled are unable to interact with their environment appropriately. Many toys and play items are inaccessible to these children due to their demand for physical manipulation and control. These same children are often unable to engage in vestibular stimulation which is conducive to sensory integration. This type of rotational movement is provided by the popular commercial toy, the "Sit 'n Spin". This toy, however, is not accessible or practical for use with physically disabled children. The adapted sit-n-spin provides the same type of movement while accommodating the seating and positioning needs of cerebral palsied children. Its most important feature, however, is its ability to be controlled by the children themselves. By using the sit-n-spin with a commercial timing device, the child is able to activate the single switch which rotates the sit-n-spin for a pre-set amount of time. In this way, the device is not only an appropriate recreational and therapeutic tool but an educational one as well. Some of the children who use the sit-n-spin have not yet developed the understanding of cause and effect relationships. The exciting and immediate feedback of the rotational movement is a powerful new way to teach this cause-effect relationship.



TECHNICAL DESCRIPTION

The design of the Sit-n-Spin can be divided into three parts: the rectangular platform, the powertrain, and the support box. This section will provide a detailed plan of construction for the entire system.

PLATFORM:

The platform was constructed of a 2 1/2' x 4' x 3/4" sheet of plywood. An extra piece of 3/4" plywood was added as reinforcement to the underside perimeter of the platform. An additional piece of 3/4" plywood (8" x 10") was added to the underside of the platform in the center. These pieces were glued and screwed together. The top of the platform was then covered with 3" foam and naugahyde. Two safety belts were bolted to the underside of the platform to secure the client to the top of the platform. Velcro was glued to most of the surface area of the naugahyde (to allow for attachment of the "Tumbleform Units" already in use at the CPCD) and to the sides where the safety belts touch the platform (to keep belts from interfering with rotation of platform). A 1/8" thick piece of Plexiglas (24" x 24") was glued and screwed to the underside of the platform for smoother rotation. A piece of 1/4" thick sheet metal (8" x 10") was bolted to the 8" x 10" underside of the platform. A steel shaft (1/2" in diameter) was welded to the sheet metal at 90°. A 3/16" wide and 1/16" deep groove was milled into the shaft (in which a set screw can be tightened.)

POWERTRAIN:

The powertrain of the design consists of a 1/15 HP gear motor rotating an assumed load of 150 lbs. (required torque of 216 in. lbs.) at 6.7 rpm. The motor is wired to a cord which can then be plugged into a cordless wall outlet. This outlet operates the device in conjunction with the radio frequency remote control switch. Since the output shaft of the motor lies horizontally, a set of 1:1 ratio bevel gears with a 2" pitch (for better meshing of the gears) was used to rotate the vertical shaft (the steel rod attached to the platform).

Modifications were made to the gears. The gears' inner diameters as received were 3/4". However, both the motor shaft and the vertical shaft are 1/2" in diameter. Therefore bushings with inner diameters of 1/2" have been inserted into the gears. Two set screw holes (at 90°) were drilled and tapped in each gear (with bushing inserted). A collar (with three set screws at 120°) was attached to the vertical and motor shafts to stop vertical and horizontal motion of the gears.

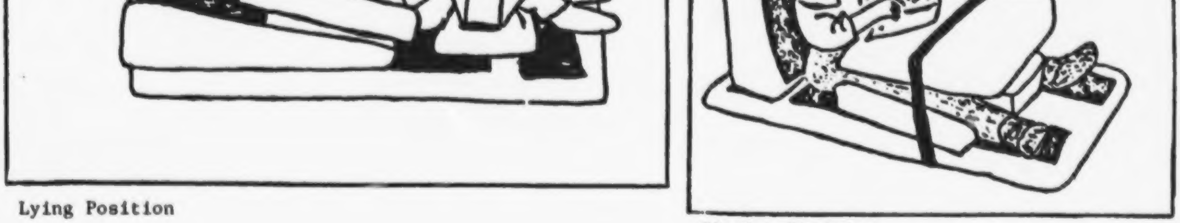
SUPPORT BOX:

A 24" x 10" box of 3/4" plywood encases the powertrain. Vertical beams were placed in the corners of the box for added support. A support block was glued to the bottom of the box to support the motor. A piece of 1/4" firm rubber was glued to the bottom of the box where the gear motor is attached. Eight swivel casters were placed on the top of the box to distribute the vertical load from the shaft to the box during rotation. An eccentrically locking bearing was attached to the ceiling and floor of the box. Four locking casters were attached to the bottom of the box to allow for transport of the device. A door consisting of a small piece of wood hinged to the side of the box (for easy access to the powertrain) with a handle for easy opening and barrel bolts to hold doors shut was made. The space in the support box surrounding the powertrain and vertical shaft was filled with poly-fil and foam rubber for sound insulation. An 18" x 18" piece of foam rubber was added to the underside of the box also for sound insulation. The outside of the support box and the added foam have been spray-painted for aesthetic purposes.

Costs for parts and construction amounted to five hundred sixty five dollars ($565).

Further details can be obtained from the principal investigator.

Positioning of child on Tumbleforms.



Lying Position

Sitting Position

"Electric Toy Jeep"
An Electric Powered Vehicle for Cerebral Palsy Children

Designers: Carl Albuquerque, Martin Fichtner, D'Angela Griffin,
Leif Hagerup, Edward Li, Vince Livoti, Mario San Juan,
Kevin Uram, Brian Wojton, Sam Zaidspiner
Disabled Coordinators: Linda van Alstyne, Kelly Howatt, Francesca Storrs
Supervising Professor: Dr. Gary A. Gabriele
Department of Mechanical Engineering, Aeronautical Engineering and Mechanics
Rensselaer Polytechnic Institute
Troy, NY 12180

INTRODUCTION

An electric powered vehicle suitable for three-five year-old cerebral palsy children has been designed and constructed for the United Cerebral Palsy Association of Schenectady, NY. The vehicle is based on an electric toy jeep manufactured by Power Wheels. The steering wheel and seats have been replaced with a joystick and child's car seat, both of which are fully adjustable to allow for easy operation by cerebral palsy children. The vehicle is powered by a rechargeable, gel cel battery that gives the vehicle a minimum operating time of approximately two hours. Other features include smooth acceleration, top speed control, and a safety cord for a therapist to hold while the child is operating the vehicle.

SUMMARY OF IMPACT

Many clients are often confined to a manual wheelchair, as they are unable to develop and refine the prerequisite skills needed to demonstrate readiness for electric mobility. While some of these clients may be able to operate a joystick, many others will require an adaptive switch to control their environment. This presents an additional challenge in finding appropriate ways to provide pre-mobility experiences. While adapted toys such as cars and robots can provide some training in movement and space, they clearly do not provide the type of experience needed to move one's self in the environment. The motorized car meets this need for several clients. The car provides adjustability in its seating, so that clients are able to operate it in various sitting positions with appropriate positioning equipment. The motorized car represents an invaluable training tool for clients to develop wheelchair driving skills and allow for future acquisition of independent mobility.

TECHNICAL DESCRIPTION

An electric powered vehicle suitable for three-five-year-old cerebral palsy children has been designed and constructed for the United Cerebral Palsy Center of Schenectady, NY. The vehicle is to be used by the Center to study the effect of providing independent mobility on the cognitive development of young cerebral palsy children. The main requirements for the vehicle are the following: 1. The vehicle must be adaptable to children in the three-five-year-old ranger with a wide range of disabilities. It was assumed that a child would have enough ability, or could be trained, to operate a joystick. 2. The vehicle would be used in the Center, therefore it should fit through the doors in the Center and be very maneuverable. 3. The vehicle should use a readily available and rechargeable power source. 4. The vehicle should be appealing to children and should not look like a wheelchair. 5. The vehicle should be safe to operate.

The vehicle is based on a Power Wheels toy jeep that was donated by the Center to the project. The vehicle is driven by a pair of electric DC gear motors that are attached to the rear wheels and were part of the original toy jeep. The motors are controlled by a control system that determines which wheels will come on and in what direction. Using this arrangement allows the vehicle to be driven and steered by the rear wheels. The vehicle can move forward (both motors forward), backward (both motors backward), or rotate left or right (one motor on forward, the other off). The front of the vehicle is supported by two casters which are attached to the frame and raise the original front wheels off the ground. The motors are powered by a 12 volt gel cell rechargeable battery. Braking is accomplished by using the dynamic braking of the motors.

The control system of the vehicle accepts input from the joystick and controls power to the motors. The control system is made up of three major subsystems: the relay system, the speed control, and the joystick. The relay system is made up of six relays which control power and polarity to the motors. The speed control system is a pulse width modulation system that smoothly accelerates the motors and controls their top speed. The top speed can be adjusted by a knob under the hood of the vehicle. The joystick is a modification of a video game joystick known as the Ergo Stick. This joystick uses four micro switches which were easy for the children to operate and provided good tactile feel. A safety switch is provided at the back of the vehicle with a safety cord that the therapist holds. If the child is in danger, the therapist pulls on the cord to remove the switch and disable the joystick.

The seat of the vehicle is an adapted child's car seat that has a hinge between the back and seat bottom. The seat bottom is mounted to a six-way power seat adjustment adapted from an old Cadillac automobile. This provides the seat with height, fore and aft, and tilt motion, as well as allowing the seat back to recline. The joystick is mounted on a tray in front of the seat and is adjustable for height, left and right, and fore and aft positioning.

The final cost of the vehicle, not including the cost of the original vehicle, was approximately three hundred eighty two dollars ($382).

Further details can be obtained from the principal investigator.

"Wake-Up Alarm Clock"
A Self-Setting Alarm Clock for the Functionally Impaired

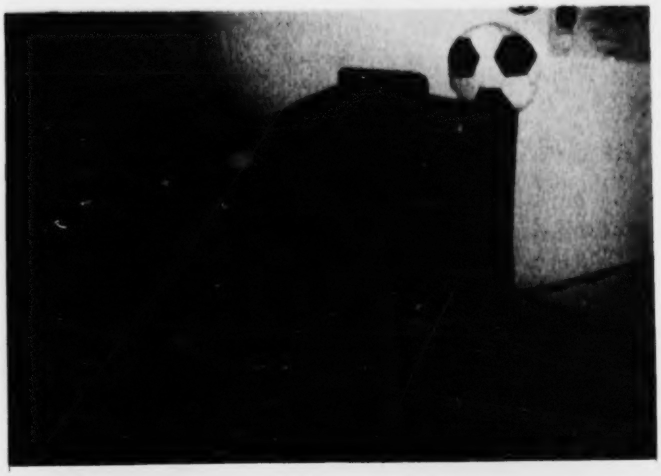
Designers: Donald Dione, Kenneth Scioscia, Scott Bialik
Disabled Coordinator: Beverly Maszdzen, Albany CP Center for the Disabled
Supervising Professors: Dr. J. Lawrence Katz and Dr. Jonathan C. Newell
Department of Biomedical Engineering
Rensselaer Polytechnic Institute
Troy, NY 12180

INTRODUCTION

A two-component alarm clock system for the functionally impaired has been developed. The system has two components: First, the mechanical sub-system. This includes a three-input switch system and the casing to hold these switches. The second sub-system is the electronics. These include the logic to control the alarm clock from any three-input system and the circuitry to control the feedback lights of the switch system.

SUMMARY OF IMPACT

One of the primary goals of programming for the developmentally disabled adult is the acquisition of skills necessary for independent living. While many clients may be unable to achieve independent living, they may be placed in a community residence. In such placements, the ability to independently control one's environment is of paramount importance. Such independence may include the responsibility of waking and preparing for work reliably. Setting an alarm clock presents a physical challenge beyond the capabilities of many clients who may at best possess gross hand movements. The adapted alarm clock allows for easy access by using three switches for operation. This implies that any three mechanical input systems can be interfaced with the electronics, making the clock appropriate for use by a variety of clients who may all activate different types of switches with different body parts. The alarm clock represents an important step in the process of acquiring control over one's environment and ultimately, toward independence.



TECHNICAL DESCRIPTION

A two-component alarm clock system for the functionally impaired has been developed. One major component of this device is the mechanical sub-system. This includes a three-input switch system and the casing to hold these switches. The switches are made of 3/4" plexiglas squares with dimensions of 5.5" x 6". Each of these Plexiglas squares is held in place by three Plexiglas C-brackets. The C-brackets were made from Plexiglas strips with the dimensions of 6" x 0.5" x 1". These strips have a groove milled into them so that they hold the Plexiglas squares in place and also allow a clearance of 3/8". This distance was required for the clearance of a common pulse push switch. The switches are also spring-loaded so that the weight of the Plexiglas squares does not activate the switches. These components are attached to a large irregularly-shaped aluminum box. Padding and fabric have been added to give the apparatus the appearance of a large pillow.

The second sub-system is the electronics. These include the logic to control the alarm clock from any three-input system and the circuitry to control the feedback lights of the switch system. The master switch toggles among three states: ALARM OFF, ALARM SET, and ALARM ON. The other two switches are used to change the hours and minutes when setting the alarm. All the switches are lighted when pressed; this serves as a feedback system to the user. The main switch is either green, yellow, or off, depending on which mode the system is in. The other two switches illuminate red when they are activated. The circuit is a set of CMOS logic functions with two JK flip-flops that allow the switches to control the clock. A 555 timer is used as a clock to run the flip-flops. The logic has low as 0V and high as +12V. This is interfaced with an existing Radio Shack alarm clock by adding the voltages in the clocks -12V to simulate the alarm clock switches. Also the clock's power was used for this purpose, so no batteries were needed.

Total cost for this system was two hundred sixty one dollars ($261).

Further details can be obtained from the principal investigator.

"Modified Toaster"
A Toaster Modified for Operation by the Manually Impaired

Designers: Karen Bookman, Nelson Sanchez, Christopher Blum
Disabled Coordinator: Beverly Maszdzen, Albany CP Center for the Disabled
Supervising Professors: Dr. J. Lawrence Katz and Dr. Jonathan C. Newell
Department of Biomedical Engineering
Rensselaer Polytechnic Institute
Troy, NY 12180

INTRODUCTION

The product is a toaster modified for use by people with limited dexterity and upper body motion. This toaster has a control panel from which functions can be controlled by the user. The control panel is a 10" x 17" x 2" aluminum box which contains three 4"-diameter control buttons. Each of these buttons has a set of lights that turn on when a function is activated. The bright colors of the lights and the large buttons make it easy to use in cases of visual impairment. The whole unit is encased in a moisture-proof covering convenient for cleaning. There are spaces on the control panel where labels can be placed. This feature is specifically for those client who require a different labeling system.

The control panel is portable and is attached to the toaster by a ten-foot cord. This enables the customer either to use the panel away from the heat of the toaster, or to place it on the lap tray of a wheelchair. The toaster itself is driven by motors that are controlled by the panel. The user can toast two or four pieces of bread at one time; one of three different degrees of darkness for the toast can also be selected.

SUMMARY OF IMPACT

For many developmentally disabled adults, the focus of their programming is on those activities of daily living such as grooming, cooking, and self-care. The kitchen environment presents multiple challenges to the physically disabled person. The levers, buttons, and settings on household appliances are physically inaccessible and cognitively demanding. Many of these clients do not have functional use of their upper extremities and can, at best, use a headpointer or a gross hand motion. Often the developmentally disabled adult is unable to independently use these appliances, and is forced to rely on co-active assistance. Food preparation remains a motivating activity as well as a functional task. The modified toaster allows the client to have control over the appliance's operation. This control entails being able to set the time of toasting, and activate the levers on the toaster's front panel to actually start toasting the bread. Adaptations include mechanical modifications to drive the toaster handles down, and a control panel that acts as an interface between the client and the appliance, thus providing the client with a degree of freedom and control they previously lacked in their environment.

TECHNICAL DESCRIPTION

The toaster, a four-slice unit owned by the Albany C.P. Center for the Disabled, could not be utilized by clients who participate in a training program. The toaster has been modified to allow the client to become more involved in the experience of independent living. The modification design takes into consideration the functional abilities of the client, e.g., muscle coordination, visual impairment and inadequacy of cognitive skills. A control panel housing three switches and electronic logic circuitry directs electronics that are housed in an extension. The extension is built as part of the toaster itself. The control panel and the toaster are connected via a ten-foot cable.

Electronic circuitry controls the entire operation of the toaster. This control, accomplished by three switches, includes the selection of heating elements, the duration of toasting cycle, and the start time. The choice of how many heating elements are activated was a requirement for the toaster to become a training aspect. Logic circuitry using NOR GATES, OR GATES, resistors, capacitors and a DECADE counter are employed for switch #1. Switch #1 governs whether two or four heating elements are to be used. A linear actuator, an A.C. reversible motor having a threaded shaft, receives an electrical signal from the logic circuitry and rotates CCW. Attached to the threaded shaft is a steel rod that forces the toaster handles down until they lock in place for toasting. At this point, the activation of a microswitch trips a relay which forces the current in the motor to reverse direction and thus reverse the motor rotation. The motor circuit uses a triac as a switch which passes an A.C. current.

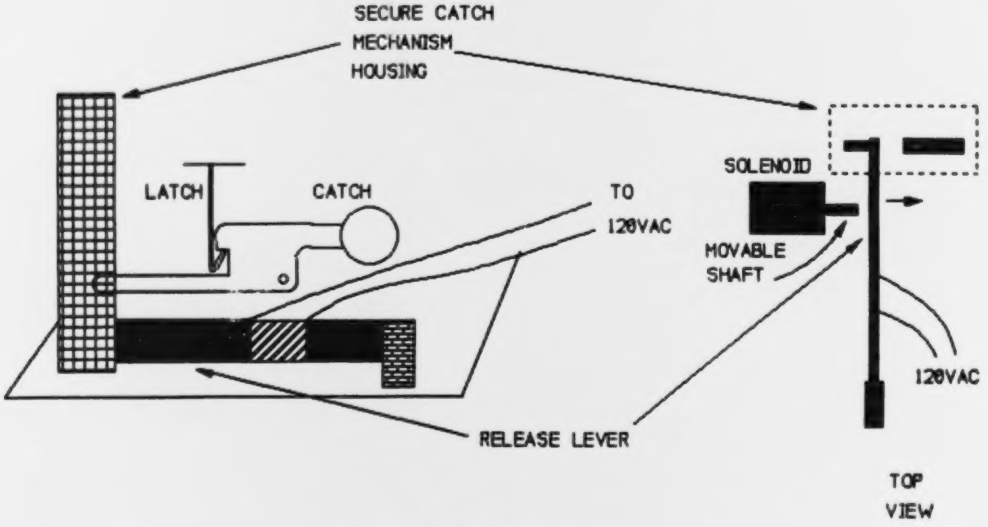
Switch #2 controls the time that the toast remains in the toast cycle. The circuitry consists of NOR GATES, AND GATES, resistors, capacitors and a DECADE counter. The AND GATES use an input from the OR GATES of switch #1 to decide what side of the toaster will be on. The client has three choices of toasting time which are accomplished by three different RC networks. The latch and catch mechanism that was initially used in the toaster was slightly modified to allow a solenoid plunger to release the mechanism. Depending on the time constant selected, two 555 TIMERS act as the time delay circuitry. The solenoid is activated for one second and forces the release mechanism, popping up the toast.

Switch #3 permits switches #1 and #2 to perform the operations selected by the client. All the outputs from switch #1 and switch #2 go to a relay that is normally open. When switch #3 is activated, the relay becomes energized and the selected signals are passed to perform the operation desired. Switch #3 also sends an inhibiting signal to both decade counters of switch #1 and switch #2. This inhibiting signal deactivates the first two switches during the operation. After the toast pops up, a microswitch is activated which resets switch #3. By resetting switch #3, the relay becomes de-energized and switches #1 and #2 are active to make another selection.

A power supply consisting of a transformer, a full wave rectifier and two voltage regulators provides the necessary current and voltages to the circuitry. The transformer is rated to provide a maximum of 2 amps of current. A fuse is provided for protection from shorts.

The cost of parts and construction was four hundred thirty dollars ($430).

Further details can be obtained from the principal investigator.



CATCH RELEASE MECHANISM

"Remote Control Dune Buggy"
A Toy Radio-Controlled Car for Wheelchair Simulation

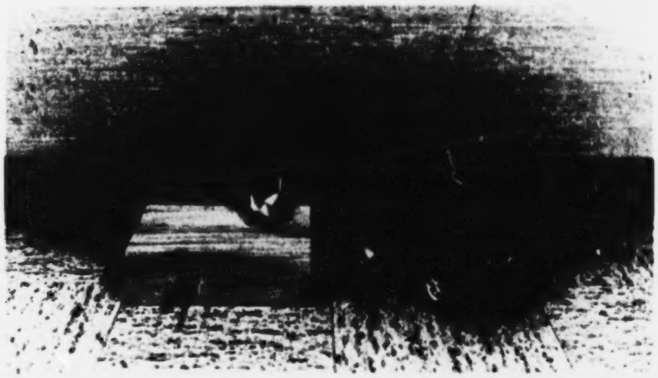
Designers: Brontie Benn, Yvette Richardson
Disabled Coordinator: Beverly Maszdzen, Albany CP Center for the Disabled
Supervising Professor: Dr. J. Lawrence Katz
Department of Biomedical Engineering
and
Department of Electrical, Computer, and Systems Engineering
Rensselaer Polytechnic Institute
Troy, NY 12180

INTRODUCTION

This project involves using a toy radio-controlled car as a wheelchair simulation to train a handicapped client to eventually be able to use a wheelchair. With the simulation, it is hoped that the client will be able to enhance his/her perception of space and motion. It also serves as a playtoy providing entertainment for the child.

SUMMARY OF IMPACT

For many young children with physical disabilities, the potential for independent mobility through an electric wheelchair is difficult to determine. Due to physical inability to move one's self, or to move toys in space, these children often do not develop the prerequisite skills necessary for the operation of a wheelchair. These skills include the perception of space, time, and speed concepts. These same children require adapted switches in order to control items in their environment. The various types of physical disabilities demonstrated by the cerebral palsied population imply that each child needs to be assessed for the particular switch and body site to be the activator. The remote control dune buggy accommodates a variety of interchangeable switches. The buggy is radio-controlled, motorized, steerable and has the directional mobility necessary for a wheelchair training device. It is large enough to fit a doll of approximately four inches in the front seat. Also, the buggy is large enough to be weighed down for speed control and is attractive to the children. This device provides indirect/observational experience of spatio-temporal concepts in a fashion that will have meaning and value to the children. It also provides a "normalizing" play experience for children who are unable to directly manipulate a doll.



TECHNICAL DESCRIPTION

A toy radio-controlled car has been converted into a pre-wheelchair training device by transforming the controls of the transmitter into controls that could be performed by a joystick or other control mechanisms. The transmitter was rewired so that it could be controlled by the joystick. Since most control devices for the handicapped (waferboards, joysticks, etc., include a nine-pin port as the interface, the Turbo Beetle's radio control was modified so that it is now compatible to most control devices by the incorporation of a nine-pin port to its transmitter. The nine-pin port allows the wheelchair training device (Turbo Beetle) the versatility of using a multitude of possible control devices, thereby enabling its use by a vast range of clients. A velcro strip was attached to the joystick so that the client's hand could be held in place while he/she is learning to control the car.

An Atari joystick interface was attached to the system so that it could be used with other devices to train other clients to use this technology. Many clients cannot use the joystick; some must use a waferboard or head pointer. This interface can be used to plug these devices into the joystick.

Finally, a wooden case was built to enclose the design. This case includes the following: (1) Rounded corners to insure that there would be no injuries to any of the clients. (2) A hole for the joystick to insure its stability and to enable the client to have constant contact. (3) A place for the antenna of the transmitter so that it can be pulled in/out as needed. (4) Extra space on the box where a hole can be made for a new switching device that will be more suitable for the client. (5) A drop-out bottom to open the case, which is held together by rounded pegs.

The cost of parts and construction was approximately eighty two dollars ($82).

Further details can be obtained from the principal investigator.

"Motorized Scooter"
A Kinetic-Interaction Device for Disabled Students

Designers: Samie Niver, Angela Acito, Lawrence Vaughan
Disabled Coordinator: Beverly Maszdzen, Albany CP Center for the Disabed
Supervising Professors: Dr. J. Lawrence Katz and Dr. Jonathan C. Newell
Department of Biomedical Engineering
Rensselaer Polytechnic Institute
Troy, NY 12180

INTRODUCTION

A motorized scooter to be used by CP children has been designed and fabricated. There are three main purposes for this scooter: (1) To teach the concept of cause and effect. (2) To allow interaction with the environment. (3) To prepare the child for future wheelchair use.

When the client is in the sitting position, he/she will be secured in the seat with chest and lap belts, his/her feet will be secured in the leg rest, and the seat itself will be locked into the lowest position. By adjusting a leaning chair device, the client can recline at angles down to 30 degrees. To accommodate the client in the prone position, the chair device is released and the bottom of the seat is raised to the highest position. A triangular cushion is strapped to the bottom and the back of the seat, and the client is secured to this cushion by adjustable straps. The control arm can be adjusted for the client's comfort. The joystick can be detached so that the therapist can operate the scooter. There is also a safety kill switch on the back of the scooter so that the therapist can override the user.

SUMMARY OF IMPACT

Currently, there are many clients who have the potential to operate an electric wheelchair. These clients are often confined to a manual wheelchair, as they are unable to develop and refine the prerequisite skills needed to demonstrate readiness for electric mobility. These skills include perception and control of space, directionality, time, and speed. While some of these clients may be able to operate a joystick, many others will require an adaptive switch to control their environment. This presents an additional challenge in finding appropriate ways to provide pre-mobility experiences. While adapted toys such as cars and robots can provide some training in movement and space, they clearly do not provide the type of experience needed to move one's self in the environment. The motorized scooter meets this need for several clients. It provides a powerful evaluation tool for possible future electric wheelchair acquisition. The scooter provides adjustability in its seating, so that clients are able to operate it in prone and various sitting positions with appropriate positioning equipment. While its purpose is to allow for independent exploration, issues of safety remain so that a control switch is included for the therapist/teacher to override the mechanism. The motorized scooter represents an invaluable training tool for clients to develop wheelchair driving skills and allow for future acquisition of independent mobility.

TECHNICAL DESCRIPTION

The four-wheel rectangular frame was constructed of one-inch square steel beams welded together. The aluminum armrests were welded to the frame.

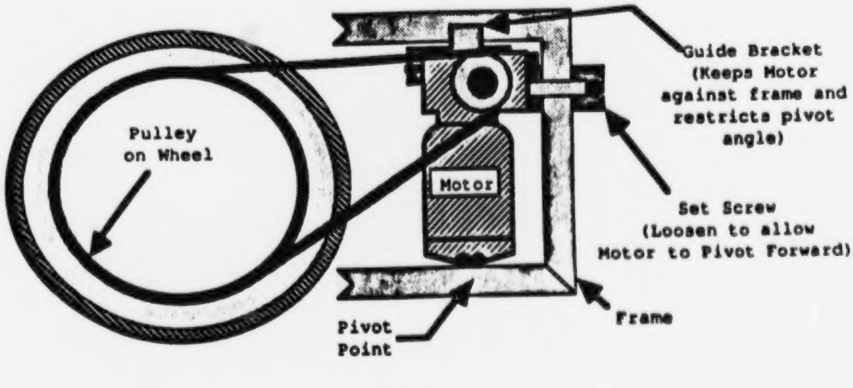
The vehicle is driven by two Klaxen 1/8-horsepower DC motors. The vehicle was designed to travel at a maximum speed of 4.4 ft/sec. The two main wheels are driven by the motors by a three-to-one pulley ratio. To power the motors, one 12-volt gel-cell battery was used. In order to prevent overloading, three 35-amp circuit breakers and two 30-amp "slo-blo" fuses were attached to the positive terminal of the battery.

A Naugahyde upholstered seat with a headrest, legrest and a reclining feature was designed and constructed. The headrest was made an optional feature; the legrest can be adjusted angularly. The reclining feature is from a Morse chair. The Morris chair mechanism allows the client to be accommodated at reclining angles as low as 30 degrees. The back of the seat can be released (down) to 180 degrees so that the client can be accommodated in the prone position.

The control system controls the flow of power from the battery to the motors by microswitches. The control arm is attached to the side of the armrest by a bolted steel housing. The L-shape of the control arm will meet the client's needs in both the sitting and the prone positions.

Parts and construction cost four hundred ninety dollars ($490); an additional four hundred dollars ($400) worth of parts was provided by the Albany CP Center for the Disabled.

Further details can be obtained from the principal investigator.


Guide Bracket
(Keeps Motor against frame and restricts pivot angle)
Pulley on Wheel
Motor
Set Screw
(Loosen to allow Motor to Pivot Forward)
Frame
Pivot Point

Motor & Clutch Assembly

"The Joystick Positioning Table"
A Device for Assessing Positioning of Joystick Controls for the Functionally Impaired

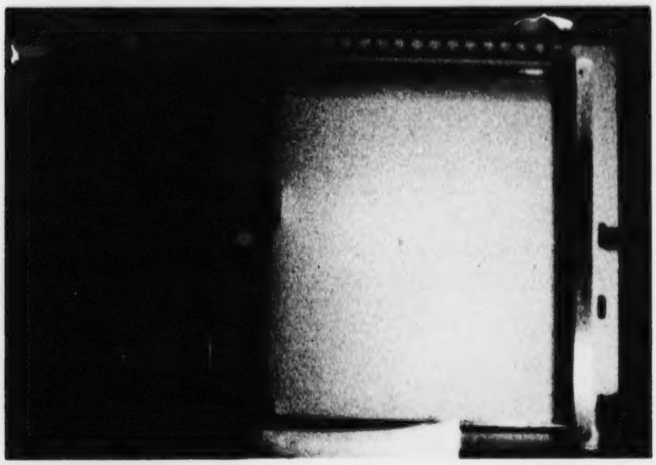
Designers: Andrew Keegan, Marcia Holbrook, Ann Polanki
Disabled Coordinator: Beverly Maszdzen, Albany CP Center for the Disabled
Supervising Professors: Dr. J. Lawrence Katz and Dr. Jonathan C. Newell
Department of Biomedical Engineering
Rensselaer Polytechnic Institute
Troy, NY 12180

INTRODUCTION

Many individuals who can control an electric wheelchair do not have good motor control in the standard areas where joysticks are usually placed on the arms of an electric powered wheelchair. The Joystick Positioning Table is an assessment tool used by the occupational and physical therapists of disabled clients to help them determine where to place the joystick on the wheelchair. The device is attached to a Plexiglas tray that can be secured to the arms of a wheelchair, or situated on an adjustable table. A simulation of a joystick is moved around by the therapist and locked into place so the client can try it out. The positioning motion is carried out through the use of linear bearings that run on shafts in the front-to-back, side-to-side and vertical directions. Angular adjustments of the joystick position are also allowed by the motion of a ball-and-socket joint. Once the suitable placement of the joystick is determined, the therapist reads its location through the use of the inscribed measuring system. Several different joystick tops are also included with the device which allow the correct handle for the individual client to be determined at the same time.

SUMMARY OF IMPACT

Currently there are many clients who demonstrate the cognitive and spatial skills necessary to operate an electric wheelchair. Often these clients receive limited exposure to the trial use of an electric wheelchair due to limited joystick types and limited positioning available to use for assessment. In some cases, a wheelchair may be ordered without the proper joystick alignment being determined, delaying mobility training significantly. In addition, these clients may be able to operate computer software programs via a joystick, but receive limited exposure for similar reasons. The use of this device enables the client to gain independence through the use of a wheelchair or a computer in a much shorter period of time. Each client is able to test the various joystick positions and achieve the most optimum placement through trial and usage. The therapist has the ability to move the joystick in all directions until the best position is found where the client can control it efficiently, and in the best possible pattern. This type of assessment tool allows the client to have the most suitable joystick ordered at the same time as their wheelchair is ordered. Thus, electric wheelchair mobility training could begin immediately. Through the use of the joystick positioning table, the therapist is able to complete a normally time-consuming task much more quickly and efficiently.



TECHNICAL DESCRIPTION

For many disabled people, the ability to operate a joystick is an important means of obtaining a degree of independence and self-sufficiency. These joysticks can be adapted to run electric wheelchairs, computers, and many other pieces of equipment. Due to physical considerations, however, many disabled individuals are unable to operate the standard joystick in the standard positions. Consequently, an occupational therapist must work with the client in assessing the abilities of the client and in determining the optimal placement of a joystick.

To assist the occupational therapist in this task, a Joystick Positioning Table (JPT) has been designed. This device allows the occupational therapist to evaluate how well the client can use a joystick in various positions.

In order to accommodate the needs of the client, the JPT contains a joystick simulator which can be moved in three dimensions and can be adjusted at various angles. To accomplish these degrees of movement, a durable, smooth-rolling system has been developed.

This system begins at the base with a solid piece of Plexiglas. On top of this base are aluminum frame ends which serve as supports for two horizontal, 23" long 1/2" steel shafts. On each shaft, aluminum housings with linear bearings are allowed to slide side-to-side. The two housings are connected by two shorter (18") 1/2" steel shafts. These shafts are perpendicular to the first two shafts so that they can provide for front-to-back positioning.

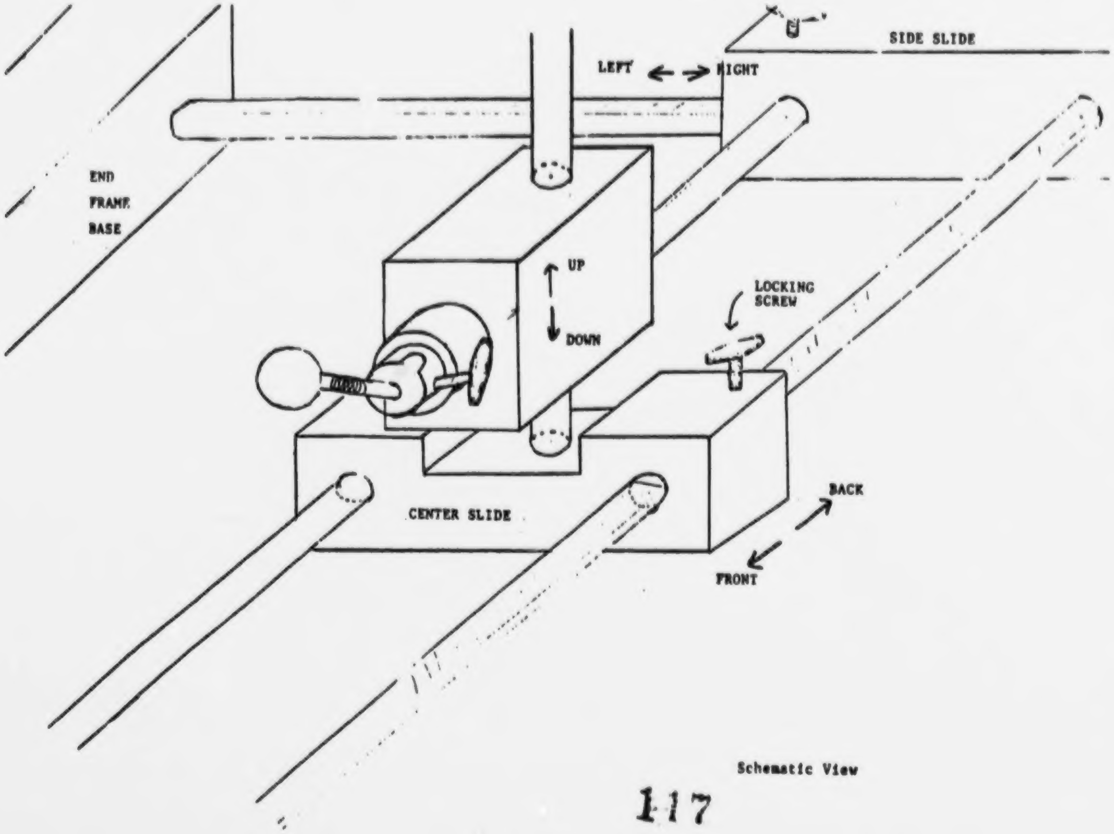
To allow for vertical positioning, another aluminum block which runs along the front-to-back shafts contains an 8"-tall, 1/2" vertical shaft. Surrounding this shaft is a small aluminum block which also holds a camera tripod top. This top contains a ball-and-socket type mechanism which acts as the angular adjustment for the joystick simulator. The actual simulator, which is connected to the tripod top, is comprised of a threaded rod, a spring for bending, and a coupler to attach various joystick tops.

Each direction of movement can be locked easily by tightening knobs which go through the aluminum housings and lock onto the shafts. For locking the side-to-side and front-to-back positions, a flat has been milled on the shafts so that marring does not inhibit the motion of the linear bearings. For locking the up-and-down position and also for preventing rotation, a keyway has been milled into the vertical shaft. A locking knob is also provided on the camera tripod top to lock the angular position.

Two parts which are specific to this design are the linear bearings, model LMB-3 from Winfred M. Berg, Inc., and the camera tripod top, model 3293 from Bogen.

The cost of parts was one hundred eighty dollars ($180); an additional four hundred fifty-two dollars ($452) was required for machining various parts. Thus the total cost was six hundred thirty-two dollars ($632).

Further details can be obtained from the principal investigator.



Schematic View

"Feedback Kneebrace"
A Feedback Device to Alert when Hyperextension of the Knee Occurs

Designers: Robert Cargill, Shelly Petronis, Nelson Rosen
Disabled Coordinator: Beverly Maszdzen, Albany CP Center for the Disabled
Supervising Professors: Dr. J. Lawrence Katz and Dr. Jonathan C. Newell
Department of Biomedical Engineering
Rensselaer Polytechnic Institute
Troy, NY 12180

INTRODUCTION

The client is a five-year-old male who hyperextends his right knee during upright activity (bends backwards, e.g., the lower leg bends too far forward). The client is unable to control this hyperextension because he usually is not aware that it is happening. If he knew when he was hyperextending his knee, he would be able to stop doing it. The task was to design and build a device which tells him when he is hyperextending. This device is called the HSU (Hyperextension Signaling Unit).

The HSU slides onto the client's leg like a sock. It is pulled up on the leg until the kneecap is in line with a large hole in the center of the HSU. When it is in proper position on the leg, the client may proceed with any daily activity (except water sports). When he hyperextends, the HSU will turn on an electric buzzer to tell him his knee is hyperextending. When he bends his knee back into the normal range of motion, the buzzer will turn off. The HSU is powered by a rechargeable AAA battery. The battery and hinge system can be removed for washing the sleeve.

SUMMARY OF IMPACT

A variety of gait deviations are demonstrated by the cerebral palsied client. Hyperextension of the knee can produce a slow and stressful gait pattern. Often the type of verbal and visual feedback from the physical therapist may be insufficient to correct the deviation. The Hyperextension Signaling Unit (HSU) was designed to signal the client when his knee hyperextends so that eventually he can learn to control the degree of knee extension used while upright. The HSU was designed for comfort, convenience, aesthetic purposes, low cost and wear resistance. The HSU uses a neoprene sleeve to hold a Plexiglas hinge to the client's knee. This hinge actuates a rotary switch, turning on a buzzer while the knee hyperextends. The buzzer, battery and switch are attached to the hinge and contained on the sleeve. The HSU will signal the client while the angle between his tibia and femur exceeds a pre-set angle. As a result of this auditory signal, the client will learn to control the hyperextension of his knee, producing a less stressful and more functional gait.

TECHNICAL DESCRIPTION

The task was to design and construct a knee hyperextension signaling unit (HSU) for the right knee of a five-year-old male client. The device uses a buzzer to signal the client when he hyperextends his right knee.

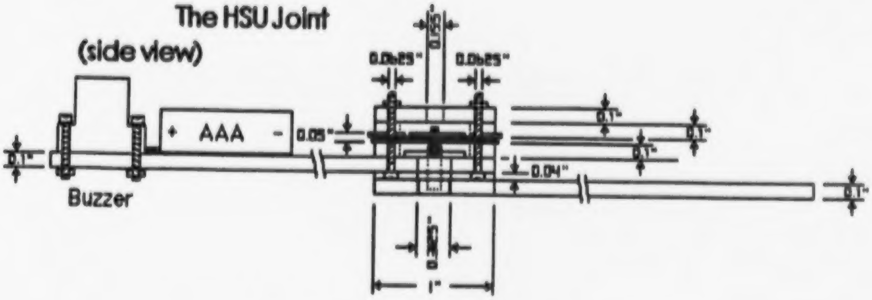
The HSU is made up of two major components: the sleeve (Fig. 1) which holds the device to the client's leg, and the hinge (Fig. 2) which actuates the buzzer.

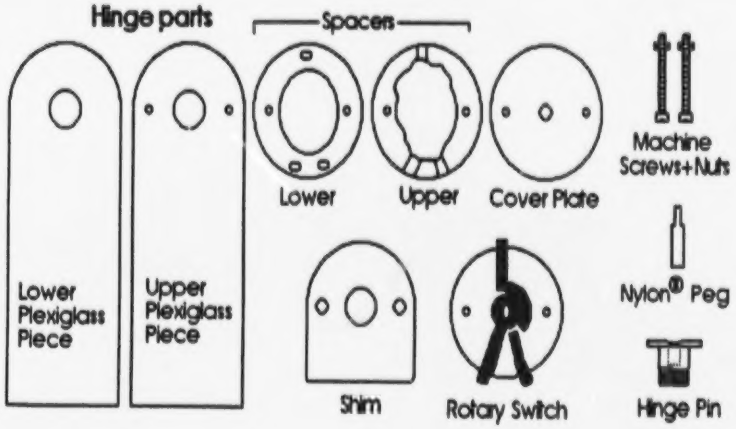
The sleeve is a Donjoy #002 extra small dense sleeve, modified to hold the hinge system in place against the leg. This modification consists of two hand-made socks that hold the hinge system in place on the sleeve. The socks are sewn to the sleeve with nylon thread. The complete modified sleeve is made of neoprene with a nylon finish on the inside and outside (Fig. 1).

The hinge system is made of 1/10" Plexiglas, custom cut to the client's measurements (Fig. 2). It contains a rotary switch located at the pivot point, actuated by the hinge pin. The rotary switch is lifted off the hinge system with a spacer to allow for switch rotation. There is a spacer on top of the switch which supports a protective cover. The hinge pin is made of a 5/16" grade 1 steel bolt that was machined to fit the system (Fig. 3). The head thickness is 1/16". This is used for the flange that holds the two hinge pieces together. A nylon peg is pressed into a hole in the top of the hinge pin. This peg fits through a hole in the center of the rotary switch, and serves to actuate the switch. The purpose of the peg being press-fit into the hole in the hinge pin is to allow the peg to be adjusted rotationally, i.e., to vary the angular position of the peg with respect to the hinge pin. A calibration tool was constructed from a phillips-head screwdriver to angularly adjust the peg.

Parts and construction cost one hundred fifty two dollars ($152).

Further details can be obtained from the principal investigator.


The HSU Joint
(side view)
0.0625"
0.0625"
AAA
+
-
0.05"
0.1"
0.1"
0.1"
0.1"
0.04"
0.1"
Buzzer
1"


Hinge parts
Spacers
Lower
Upper
Cover Plate
Machine Screws+Nuts
Lower Plexiglass Piece
Upper Plexiglass Piece
Shim
Rotary Switch
Nylon® Peg
Hinge Pin

"A Feedback Knee Brace"
A Feedback Device to Alert when Hyperextension of the Knee Occurs

Designers: A. Toppses, T. Lenihan, T. Larkin
Disabled Coordinator: Beverly Maszdzen, Albany CP Center for the Disabled
Supervising Professors: Dr. J. Lawrence Katz and Dr. Jonathan C. Newell
Department of Biomedical Engineering
Rensselaer Polytechnic Institute
Troy, NY 12180

INTRODUCTION

The Feedback Kneebrace device was designed either to make a buzzing sound or to vibrate when the client extends his/her leg beyond the point of being perfectly straight, i.e., hyperextended. This is accomplished by a hinge that is sewn to the side of a kneebrace similar to those braces used by basketball players. The hinge moves with the movement of the client's leg. When the hinge extends just beyond the point of being perfectly straight, a "hump" on the upper band of the hinge presses against a switch mounted on the lower band. In this way, power is routed to either the buzzer or the vibrator in a pocket on the lower rear of the brace and produces a signal that can either be heard or felt. (A slide-switch located on a box which contains the buzzer and the vibrator is used to select the desired signal.) Thus, the brace can be used to help train the client not to hyperextend his/her leg and to walk more efficiently, thus reducing the potential of damage to calf muscles because of hyperextension.

SUMMARY OF IMPACT

A variety of gait deviations are demonstrated by the cerebral palsied client. Hyperextension of the knee can produce a slow and stressful gait pattern. Often, the type of verbal and visual feedback from the physical therapist may be insufficient to correct the deviation. The Hyperextension Signaling Unit (HSU) was designed to signal the client when his knee hyperextends, so that eventually he can learn to control the degree of knee extension used while upright. The HSU was designed for comfort, convenience, aesthetic purposes, low cost, and wear resistance. The HSU uses a Neoprene sleeve to hold a Plexiglas hinge to the client's knee. This hinge actuates a rotary switch, turning on a buzzer while the knee hyperextends. The buzzer, battery and switch are all attached to the hinge and contained on the sleeve. The HSU will signal him while the angle between his tibia and femur exceeds a pre-set angle. As a result of this auditory signal, the client will learn to control the hyperextension of his knee, producing a less stressful and more functional gait.

TECHNICAL DESCRIPTION

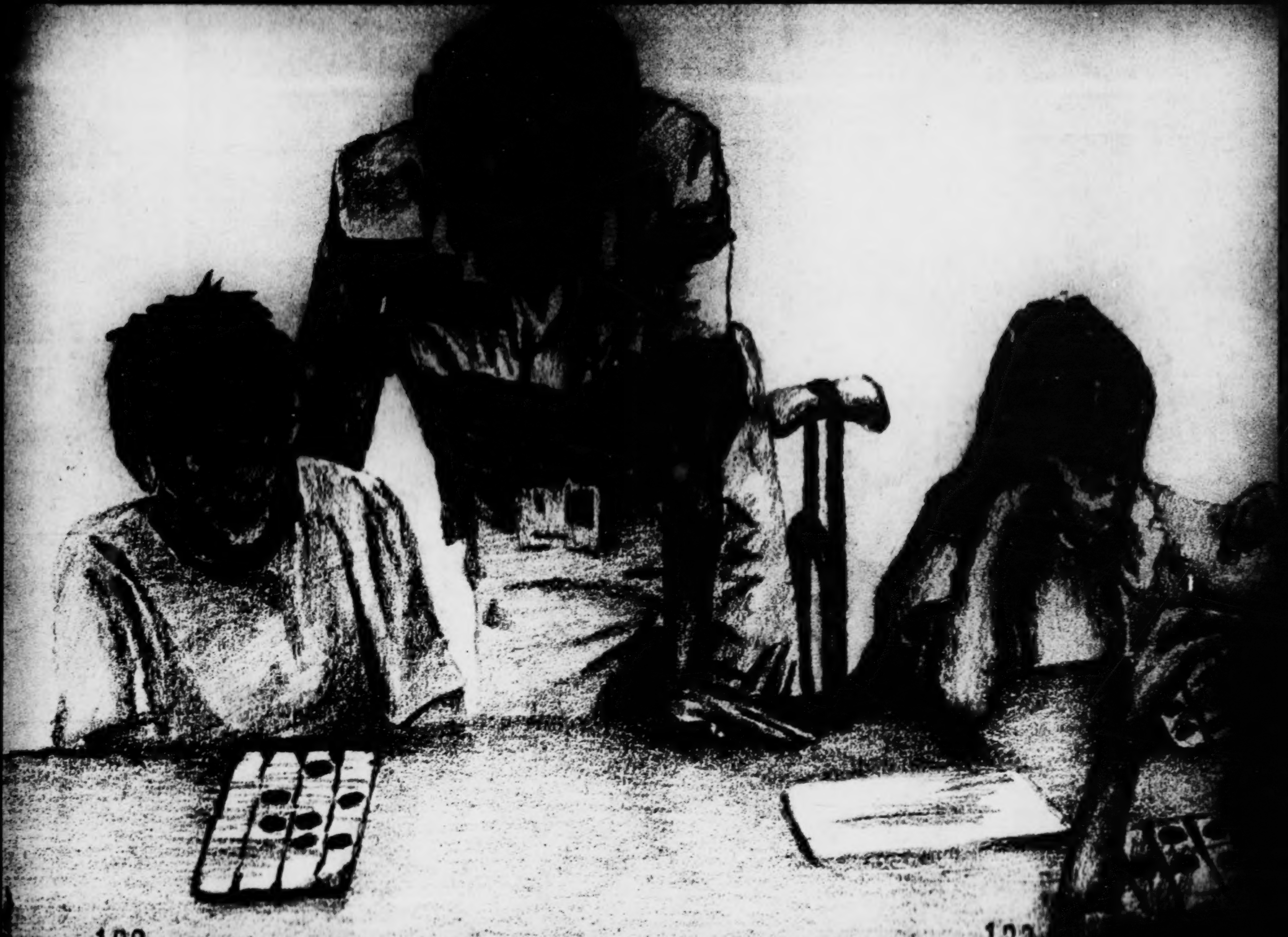
A hyperextension detection mechanism has been designed and constructed. It utilizes a machined plastic hinge approximately 30 cm long (when fully extended) attached to a knee brace. A screw at the hinge pivot goes through one leg of the hinge, then through a "cam" or "bumper", and through the other hinge leg. The cam is an elliptically-shaped piece of plastic whose purpose is to make contact with a micro-switch over a predetermined radial position range. The cam is held tight to the upper leg of the hinge by a thumbscrew. The flat end of the thrumscrew is recessed into an adjustment slot in the cam so that it will not rub on the lower hinge leg. Thus, when the thumbscrew is loosened, the rotational position of the cam relative to the upper hinge leg can be adjusted, allowing for the adjustment of the activation point of the hinge mechanism. This hinge is mounted on the brace via pockets that contain most of the length of the uper and lower hinge legs.

Once the cam on the hinge makes contact with the micro-switch, a circuit consisting of a selector switch in series with a three-volt power source (two "AAA" batteries) is completed. The selector switch routes current either to a buzzer (for the signaling option using sound) or to a motor with an off-center weight placed on its drive shaft (for the vibrational signaling option). The buzzer, motor and selector switch are all contained in a signal box 3.9 cm wide, 5.7 cm long, and 1.8 cm thick. This box, along with the two "AAA" batteries, is held in a tight pouch at the lower rear of the brace (on the client's upper calf).

The brace which serves as the mounting base for the detection-signaling mechanism consists of a tube with a hole and pad for the patella. This hole and pad insure consistent positioning of the brace on the client's leg (since any other position is made very uncomfortable). The brace material is rubber neoprene which stretches around the client's leg preventing slip and allowing for growth. Thus, the hinge as mounted on this brace will move as the client's leg moves and will activate either the buzzer or the vibrator when the micro-switch is contacted.

The total cost of the parts which comprise the prototype is $49.75. During the course of development, however, many components were purchased redundantly (to insure a working part) or for exploration of an alternate design option that was subsequently rejected. The total cost of these parts amounted to approximately $105. Thus, the total financial investment in this project on its completion is approximately one hundred fifty five dollars ($155).

Further details can be obtained from the principal investigator.



CHAPTER 7

SOUTHEASTERN MASSACHUSETTS UNIVERSITY
DEPARTMENTS OF ELECTRICAL & COMPUTER ENGINEERING
AND ELECTRICAL ENGINEERING TECHNOLOGY
NORTH DARTMOUTH, MASSACHUSETTS 02747

Principal Investigator(s):

Lester W. Cory (508) 999-8482

Philip H. Viall (508) 999-8214

TALKING LARGE SCREEN TYPING SYSTEM

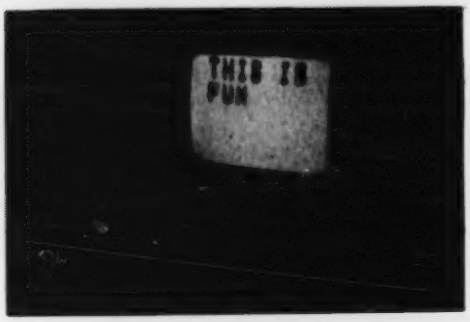
Designer: Mark Easterday
Disabled Coordinator: Maureen Canner, Bridge Program
Supervising Professor: Professor Philip H. Viall
Electrical Engineering Technology Department
Southeastern Massachusetts University
North Dartmouth, MA 02747

INTRODUCTION

The Talking Large Screen Typing System is a combination of hardware and software which enables a severely visually impaired girl who also has Cerebral Palsy to produce printed documents. The system consists of a computer,a voice synthesizer, a printer capable of producing large, bold letters and the Talking Large Screen Typing System program.

Every character which is typed is both spoken by the synthesizer and displayed on the monitor screen. The monitor reproduces each character in 2 inch high letters and is capable of displaying 5 lines of text with 8 characters per line. The user can backspace to make corrections.

The contents of the screen is sent to the printer by pressing the "print" key. The printer is configured to print up to 40 characters (one full screen) of enlarged characters on each line.



SUMMARY OF IMPACT

The user of the Talking Large Screen Typing System is a 13 year old girl who has Cerebral Palsy. She is almost totally blind and lacks fine motor control. She is unable to write with a pencil and she cannot read normal size text even with glasses. She is able to see bold type double size letters by holding them within a few inches of her eyes and she is able to read the 2 inch high letters on the TV screen from a distance of about 2 feet.

Prior to receiving the Typing System, she had no way to produce legible written work. No effort had been made to teach her to type because she could not see the keys nor could she see the letters produced by typewriters. All of her school work was dictated, a process which was made difficult by her severe speech impediment. Her reading was at least several years behind grade level.

It has taken her some time to find her way around the keyboard but she is doing well. Large letters were glued over the key caps which she could see by bringing her face down to within a few inches of the keyboard. As the letters gradually fell off, they were not replaced.

Today she is able to do most of her writing without assistance. Her sight word vocabulary has quadrupled and she does more reading on her own. For the first time, she can write a letter unassisted, something she is doing with greater frequency.

TECHNICAL DESCRIPTION

The system uses a Radio Shack TRS-80 Color Computer, a 21 inch television receiver, a Votrax voice synthesizer, a line printer and the Talking Large Screen Typing System program.

As keys are pressed on the keyboard, the text appears in large print on the screen. The information is also sent to the speech synthesizer to be spoken. The synthesizer is sent three types of data: data to be spoken, commands, and data to be sent to the printer. If the synthesizer is sent a command to speak the data it is sent, it will echo each key as it is pressed. For example, if the "A" key is pressed, the synthesizer will speak "A." If the "," key is pressed, the synthesizer will speak "comma." This gives immediate feedback to the user, so she will be aware if she presses a different key than intended. If an error is made, there is a backspace function key which will delete the last character pressed. This key is also echoed by the synthesizer which speaks the word "backspace."

In this way, the user can fill the screen with text. The screen can hold 5 lines with 8 characters to a line. At any time the entire screen full of text can be spoken by the synthesizer, or it can be sent to the printer. When the print key is pressed the synthesizer is sent commands by the computer which tell it not to speak the following data, but to send it on to the printer. Before sending the text, the synthesizer first sends control codes to the printer which set it to print in quadruple size bold letters. Once a portion of text is printed, the screen can be cleared by pressing the clear key and the user can then begin typing a new line. This allows for documents much longer than the 40 characters which the screen can hold.

As is the case with other systems described in this chapter, the system software was burned into EPROM so that no loading of tapes or disks is required.

The total system will cost about $825 to duplicate not including the television receiver which was donated.

DEAR PROF CORY

THANK YOU VERY MUCH FOR MY COMPUTER. I USE IT FOR EVERYTHING. NOW I CAN WRITE A LETTER TO YOU AND SAY THANK YOU LIKE THE OTHER KIDS DO. THANK YOU VERY MUCH.

SHERI

"TYPING TUTOR"

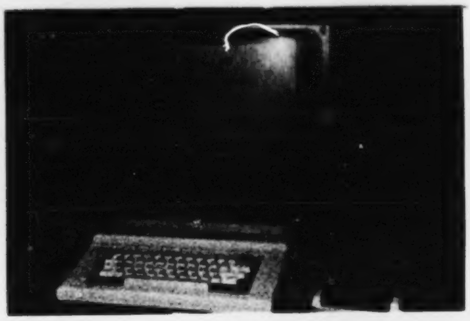
Designer: Leonard Bean
Disabled Coordinator: Laurie John, James L. Maher Center
Supervising Professor: Professor Lester W. Cory
Electrical and Computer Engineering Department
Southeastern Massachusetts University
North Dartmouth, MA 02747

INTRODUCTION

The typing tutor is a hardware - software system designed to enable a person to practice accurate typing. Its purpose is to give a disabled person, who lacks the physical ability to write using a pencil, the opportunity to improve his typing skills with the objective of securing employment.

The program displays sentences one at a time on the computer screen and waits for the same sentence to be entered from the keyboard. Each time a character is pressed, the computer responds with a tone. There are two different tones, one for correct entries and one for incorrect entries. Only correctly typed characters are displayed on the screen.

When a sentence is completely entered, the user presses the ENTER key and the system displays the number of characters typed and the percentage typed correctly. Another sentence is then displayed and the computer continues to calculate and display the user's cumulative score.



SUMMARY OF IMPACT

A 25 year old man with Cerebral Palsy was offered employment as a telephone switchboard operator provided that he could demonstrate that he had the ability to route incoming calls to the proper extension and take messages for those unavailable to answer the phone.

He is able to speak and he has the dexterity to handle the buttons and levers on the call director. The problem came in taking messages. Not only was he unable to write legibly with a pencil, he had never learned to type. A computer system was custom designed for him with pre-programmed names of employees and frequent callers and stock messages which can be printed with the touch of a single key. Most messages can actually be taken and printed with only 4 key strokes including the message, the callee's name, the caller's name and verification of the caller's phone number. Nonstandard messages can be tape recorded for transcription later. The system didn't work out because he couldn't find the keys he needed in a reasonable time. Commercially available typing programs didn't seem to help.

The Typing Tutor worked well. The sentences were chosen to capture his interest and they did. The score box let everyone who went by know how well he was doing and also how much. He worked hard to get the numbers in the score box as high as possible each day.

The system accomplished its objective. Today he is employed for the first time in his life and he is doing well. The Typing Tutor changed his attitude from "I can't" to "I Can."

TECHNICAL DESCRIPTION

The program (shown below) is written in Basic and runs on a Radio Shack TRS-80 Color Computer, although it is sufficiently generic to run on most small computers which accept Basic. The system uses the computer's standard keyboard for input.

When the program is first run, one of 150 sentences is randomly selected and displayed on the screen. The sentences are up to 32 characters long and contain no punctuation. The user is expected to duplicate the sentence by typing it one letter at a time directly under the displayed sentence. The program waits for input from the keyboard, and checks each character as it is typed to see if it is correct. Capitalization is not checked. Incorrect keyboard entries are responded to with a low frequency tone only. When the correct key is pressed, a different tone sounds and the character is displayed on the screen. A typed character will only appear on the screen if it is the correct entry in the sentence.

When the entire sentence has been typed, the message "press ENTER to continue" appears on the screen. Once the ENTER key is pressed, the numeric results are updated and displayed at the top of the screen. The first number displayed is the total number of characters typed and the second is the percentage of these which were typed correctly. The next sentence to be typed is also displayed, replacing the previous one.

After each sentence is typed correctly the results are updated and displayed. The displayed data is cumulative, showing the total number of keystrokes since the system was turned on and the percentage of those which were correctly typed. To reset the scores, the program must be stopped and restarted.

The program was converted to tokens which were then loaded into an EPROM. The EPROM was then placed in a socket which had been previously "piggy backed" over the Extended Basic ROM. A jumper in the cartridge port causes the system to boot from address C000 which was loaded with a routine to boot strap the tokens into RAM and begin program execution. Thus the program comes up running each time the system is turned on with no need to load anything from tape or disk.

The only cost incurred was that for the computer, the EPROM socket and the EPROM. A borrowed TV set was used as a video monitor. Total cost is $175.

```
10 REM  ** TYPING TUTOR  **
12 CLEAR 3000,32512
14 CLS :PRINT@165,"TYPING TUTOR"
16 N=100' # OF SENTENCES (150 MAX)
18 DIM A$(150) 'SENTENCE ARRAY
20 NT=1 'TOTAL # 0F KEYSTROKES
22 NC=1 '# OF CORRECT KEYSTROKES
24 FOR I=1 TO N:READ A$(I):NEXT
26 X=RND(TIMER):X=RND(N)
28 CLS:PRINT@40,"TRIES =";NT
30 PRINT@70,"SCORE =";INT(100*NC/NT);"%"
32 PRINT A$(X)
34 FOR I= 1 TO LEN(A$(X))
36 R$=INKEY$:IF R$=""THEN36
38 NT=NT+1
40 S$=MID$(A$(X),I,1)
42 IF R$<>S$THEN SOUND 50,1:GOTO 36
44 NC=NC+1:SOUND 145,1:PRINT R$;
46 NEXT I
48 PRINT:PRINT:PRINT
50 PRINT"PRESS enter TO CONTINUE"
52 R$=INKEY$
54 IF R$<>CHR$(13) THEN 52 ELSE 26
56 READ A$:N=N+1:GOTO 56
58 REM ** 150 SENTENCES FOLLOW **
60 DATA A PENNY SAVED IS NOT WORTH MUCH
62 DATA NOW IS THE TIME TO HAVE A PARTY
64 DATA ARE WE HAVING FUN YET
66 DATA IS IT TIME TO GO HOME YET
68 DATA LETS MAKE POPCORN
70 DATA WHAT TIME DOES THE BOSS LEAVE
72 REM ** THE REST IS ALL DATA **
```

"Talking Press-The-Picture Communicator"

A Direct Select, Multiple Page Communication Device for a Non-Reading, Non-Speaking Person

Designer: Susan Toland
Disabled Coordinator: Ronald St. Martin, Fall River Public Schools
Supervising Professor: Professor Lester W. Cory
Electrical and Computer Engineering Department
Southeastern Massachusetts University
North Dartmouth, MA 02747

INTRODUCTION

The Talking Press-The-Picture Communicator was designed to enable a physically disabled, speech impaired person who can not read but who has some manual dexterity to communicate by selecting from among one hundred and twenty different user - appropriate, pre-programmed sentences. The system consists of a Radio Shack Color Computer, a TV/monitor, a Votrax speech synthesizer, a TRS-80 Color Computer Electronic Book, a custom fabricated switch box, a set of ten custom overlays, custom software, and suitable interconnecting cables.

The user or therapist first turns to one of the ten pages in the Electronic Book, each of which contains twelve pictures. The user or therapist then rotates the ten position page selector switch to the position which corresponds to the page number of the chosen page. The user may now cause the system to speak by pressing on one of the twelve pictures on the page. Each picture is associated with a corresponding sentence in the computer's memory which will be spoken by the speech synthesizer when selected. Pressing on the picture of a drinking glass will cause the system to speak, "May I have a drink, please?," for example.

Nine of the ten pages are "fixed" in that the user cannot change the sentences on these pages without modifying the program. Page 10, however, comes up blank each time the system is turned on and is programmed each day by the teacher or therapist with sentences appropriate for that day's activities.

SUMMARY OF IMPACT

The Talking Press-The-Picture Communicator was designed to enable a severely disabled, non-vocal youngster to express his basic wants and needs and to enable him to respond to questions. The youngster has Cerebral Palsy and is moderately retarded. He is unable to speak, write or gesture. He has not learned to read but he does recognize a few words and some numerals. He communicates "YES" and "NO" through a combination of eye motion and guttural sounds. His teachers have been frustrated in their attempts to elicit reliable, meaningful responses.

The Talking Communicator has met with almost immediate success. Although the user lacks the physical dexterity to independently turn pages, he is able to indicate through eye gaze and facial expressions when he needs to have pages turned. He seldom initiates communication but he does use the system appropriately to respond to questions. Perhaps the most valuable feature of the system is the teacher-programmable page. This is used on a daily basis to teach such concepts as size, shape and colors.

The system has made it possible for this youngster to communicate with his teachers and therapists and even with some other students in his classroom. It is the first system in which he has shown any interest and the first which he has demonstrated the ability to use. For now it is an appropriate device but it is hoped that eventually he will outgrow it and move on to a more sophisticated system.

TECHNICAL DESCRIPTION

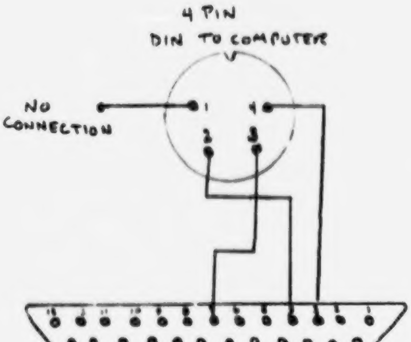
The system consists of a Tandy Color Computer with custom software loaded into an EPROM, a speech synthesizer, a Color Computer "Electronic Book" similar to a Koala Pad, a custom fabricated switch box "page selector" and interconnecting cables. If facilities are not available to transfer the software to EPROM, then the software can be loaded into the computer's RAM from tape or disk. The software is sufficiently non-system specific that it can be transported with little modification to other "Basic speaking" computers. Except for the custom EPROM pack which was implemented by soldering a socketed EPROM directly over the Extended Basic ROM, the computer is unmodified.

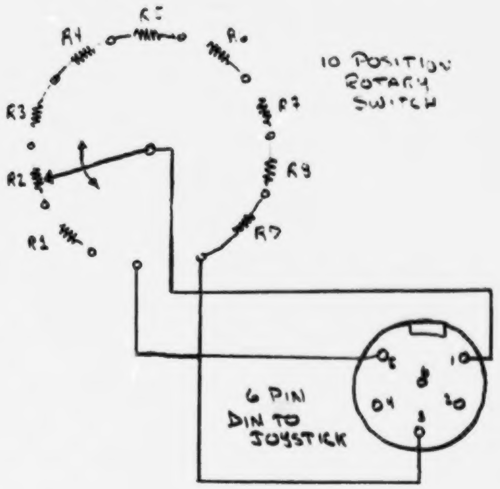
The speech synthesizer is a Votrax Personal Speech System Model 200 which is driven by the serial port of the Color Computer. Interface data from the 4 pin din plug of the computer to the DB-25 of the speech synthesizer is as follows: Pins 2-4 respectively of the male din plug are connected to pins 4(cts), 7(ground) and 3(data) of the male DB-25 connector. Pin 1 of the din plug is not connected. The 8 DIP switches on the rear panel of the synthesizer are used to select the proper baud rate, parity, protocol and interface ports. For interface to the Color Computer, the correct switch settings are 00100100 which selects serial transmission, 600 baud, RTS handshaking, 7 data bits, 1 start bit, 1 stop bit and no parity.

The Electronic Book is a touch pad which looks to the joystick ports like two 100K ohm potentiometers. Touching the upper half of the pad varies the signal at joystick port 2; touching the lower half varies the signal at port 3. The software causes the computer to repetitively scan ports 0-3 looking for changes in either the setting of the page selector or in pressure on any of the 12 touch sensitive areas of the pad. A simulation of the Electronic Book may be fabricated using discrete switches connected in parallel with elements of a resistor network. This scheme enables one to construct a touch sensitive pad of any reasonable dimension by choosing switches of appropriate surface area.

The page selector switch box connects to the computer joystick port 0 via a 6 pin din plug and a 3 conductor cable. The box consists of a network of 9 resistors connected in series around the circumference of a 10 position rotary switch. One end of the network is at ground potential (pin 3 of the din plug), one end connects to the 5 volt supply (pin 5) and the arm of the switch connects to the joystick input of the computer (pin 1). In theory, the resistors in the network should be of equal value. In practice, the two end resistors must be different in order to compensate for the internal current limiting resistor in the joystick circuit. If 10K ohm resistors are used for R2 thru R8 then R1 and R9 should be about 3300 ohms each. Some "trimming" of these values may be necessary due to variations in characteristics between different production runs of the Color Computer.

Copies of the system software may be obtained from the P.I.





"SINGLE SWITCH, ROTATING ARM SCANNING PICTURE COMMUNICATOR"

Designer: David English
Disabled Coordinator: Jaryl Sciarrappa, Kennedy-Donovan Center
Supervising Professor: Professor Lester W. Cory
Electrical and Computer Engineering Department
Southeastern Massachusetts University
North Dartmouth, MA 02747

INTRODUCTION

The single switch, rotating arm, scanning picture communicator is a communication device for use by physically disabled persons who have the physical ability to operate a single switch. An appropriate switch can be chosen to match the ability of the individual user.

Users for whom the system is appropriate must have the desire and intelligence to communicate and the mental ability to associate pictures with the idea or concept to be communicated. It is presumed that system users are unable or unwilling to read.

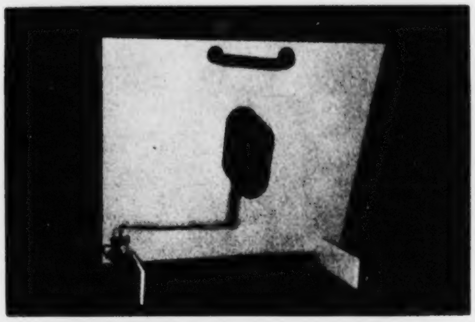
The communicator operates in one of two modes depending upon whether the therapist chooses to use a momentary control switch or a push on - push off switch. With a momentary switch in place, the arm turns for as long as the switch is held closed. Using a push on-push off switch results in the motor being turned ON-OFF with alternate pushes of the switch. In either case, when the switch is enabled, the arm rotates, passing over the pictures that are on the face plate. The user opens the switch when the arm is over the picture that conveys the idea that he or she is trying to communicate. The speed of rotation can be varied to suit the ability of the user.

SUMMARY OF IMPACT

The Rotating Arm Scanning Picture Communicator was built for use by a non-vocal, multiple disabled child to facilitate basic communication, to introduce the concept of a scanning alternative communication device and to aid in proper control switch selection.

Initial use of the system has been limited to activity selection with drawings of activity choices being placed in four of the twelve pockets. With coaxing, the child is able to make appropriate use of the system to choose among alternative activities. In time, the use of the communicator may become more of an activity in itself.

The prime objective of having the child employ an alternative device for communication is being realized and the secondary objective of having the child develop dexterity in the use of an appropriate control switch is also being met.



TECHNICAL DESCRIPTION

The unit consists essentially of a drive motor which turns an indicator dial which points to any one of a dozen transparent pockets containing pictures or illustrations. The motor is started and stopped by closing and opening an external switch which is plugged into a jack on the front panel.

The device is light weight and battery powered and can be used in the home as well as in public to allow the non-speaking person to communicate needs, desires and feelings, or to respond to questions. The illustrations on the face plate can be changed as new ideas and thoughts are needed in the "vocabulary" of the user.

The face plate of the device is a 14" X 16" piece of white, scratch resistant Lucite. The face plate also serves as the mounting chassis for the remainder of the components that make up the device.

On the face of the communicator, the illustrations are held in place in a circular pattern around the rotary indicator, in the same manner that numbers are arranged around the circumference of the face of a clock. The individual pictures are slipped into transparent "pockets" made of clear vinyl which are permanently affixed to the face plate of the communicator. The indicator is attached through a hole in the center of the face to the shaft of the drive motor.

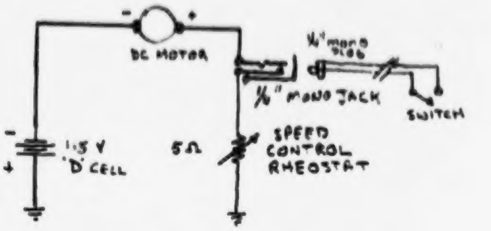
The drive unit of the communicator is an inexpensive DC motor that is sold for use as a barbecue rotisserie motor. The only power necessary to operate the unit is obtained from one standard "D" size battery. As supplied by the manufacturer, the motor has no ON/OFF switch. It is ON any time that the battery is installed. It is necessary to open the motor case and disconnect the wire leading from the positive terminal of the battery to the motor. This wire is replaced with a pair of wires about 15 inches long; one connected to the positive terminal of the battery, the other connected to the positive terminal of the motor. The free end of this pair is routed to the series combination of the input jack and speed control rheostat.

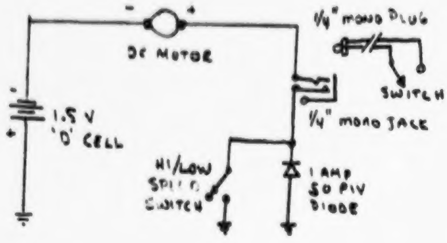
The input jack is a quarter inch phone jack mounted in the lower corner of the face plate. The speed control is a 5 ohm wire around rheostat rated to handle the starting current of the motor - about 300 ma. As the resistances is varied from 0 to 5 ohms the motor speed drops from about 4 RPM to about 1.5 RPM.

A less expensive way to control the speed is to connect a diode in series with the motor and connect a SPST toggle switch in parallel with the diode to switch it in and out of the circuit. With the switch open, the forward resistance of the diode is in series with the motor which drops the motor voltage to about 1.0 volts slowing the motor to about half speed. With the switch closed, the diode is short circuited and the motor runs at full speed.

A variety of momentary and two position ON/OFF switches are available on the market that can be modified to match the ability of the user. The switch is connected via a 1/4 inch mono plug to the jack on the face plate of the unit. When the switch is operated, the indicator turns, moving from one image to the next. When the indicator is over the picture that conveys the thought to be communicated, the user opens the switch, the connection is broken and the motor stops with the indicator pointing to the desired picture.

The Scanning Picture Communicator can be built for approximately thirty dollars ($30), including a simple array of control switches. The Communicator can be utilized to give many physically and mentally disabled persons the means to communicate simple wants and needs.





"'YES'-'NO' Talker"
A Diagnostic Device for the Communicatively Disabled

Designer: Ron Belanger and Mark Duncan
Disabled Coordinator: Jaryl Sciarrappa, Kennedy-Donovan Center
Supervising Professor: Prof. Philip H. Viall
Electrical Engineering Technology Department
Southeastern Massachusetts University
North Dartmouth, MA 02747

INTRODUCTION

The "Yes"-"No" Talker is a low cost, portable, battery powered device having two input switches. Pressing one switch results in the device speaking the word "YES." Pressing the other switch speaks the word "NO." Jacks for remote switches are provided.

The words "YES" and "NO" are stored as digitized speech in a memory chip. Because the words are essentially recordings of human speech (as opposed to synthetic speech), the words are reproduced with the same tone and inflection as when they were recorded. Simply by changing memory chips, the voice of the system can be changed from male to female to that of a child. One of the most important features of this system is that it can provide each of its users with an age and gender appropriate voice.

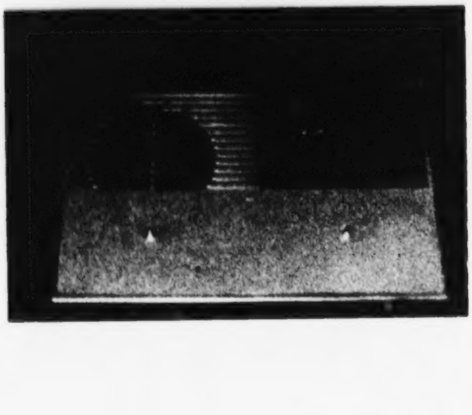
The "Yes"-"No" talker may be used as a diagnostic communication aid to achieve two goals. First, it provides a very elementary level of communication. Second, and more important, it provides motivation for an individual to communicate and to become proficient in the operation of a switch.

SUMMARY OF IMPACT

The "Yes"-"NO" talker was designed to be utilized as a diagnostic and teaching tool at a center which provides services for physically disabled and mentally retarded children. Often an individual's dexterity to operate a single switch needs to be developed before that person can make effective use of computerized menu scanning communication systems. When a menu scanning communication system is presented, even if the user understands what is required, the user may soon become frustrated if selections are missed, or if incorrect menu entries are selected.

The "Yes"-"No" talker gives the user a reason to make frequent use of a switch or switches. Once the ability to operate a switch reliably has been developed, a more elaborate communication system may be introduced. If the user is having trouble, one may always revert back to the "Yes"-"No" talker to determine the exact nature of the problem.

The "Yes"-"No" talker is an excellent first system for physically disabled children, particularly those of limited mental ability. It enables the therapist to introduce a system which a user can operate independently with minimal training and skill.



TECHNICAL DESCRIPTION

The box which contains the components is six inches deep and nine inches wide. The front (top) is sloped being four inches high at the rear and two inches high at the front. Two SPST momentary push button switches are mounted on the sloping surface. Pressing the left button results in the device speaking the word "Yes." Pressing the button on the right results in the device speaking the word "No." The device may be powered by either a 9V battery or a 9V D.C. power supply. A power switch is provided on the right side of the case. Two 1/8" mini phone jacks are provided on the back of the case for connecting a set of remote switches.

The device employs digitized speech stored in binary form in a 16K Byte CMOS EPROM. The EPROM is (logically) split into two halves. The bottom half of the EPROM is used to store the word "NO;" the top half stores the word "YES."

Speech was digitally recorded by using a Techmar Lab Tender board in an XT Clone. Speech was sampled at the rate of 8 KHz giving one second (8000 samples) of speech for each word. Each data sample was digitized into a one byte quantity by the Lab Tender board. The digitized data was then outputted via the serial port to a Data-I/O EPROM programmer.

More information on the development system may be obtained from the PI.

In order to speak one of the words stored in the EPROM, counter circuitry is employed to sequentially cycle through all combinations on address lines A0 through A12 (all but the Most Significant Bit). The state of A13 determines whether the word "YES" or the word "NO" will be spoken.

The counters are controlled by a 555 timer oscillating at 8 KHz (the same as the sampling frequency). The counters are initially cleared by an RC pull-up combination connected to the clear line(s) of the counters.

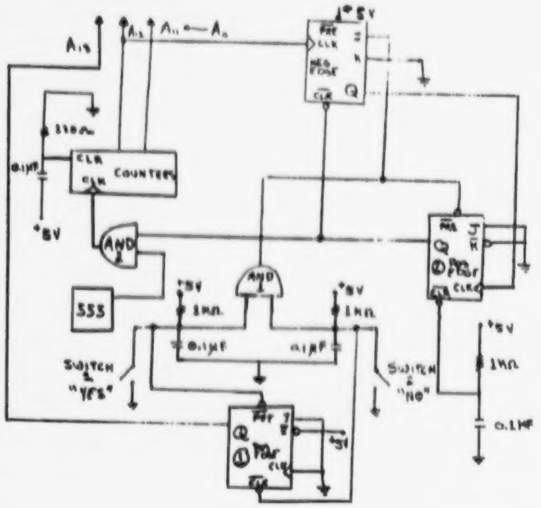
The MSB of the EPROM is controlled by a JK Flip flop (FF1) set up as a latch. Pressing the "YES" switch sets the flip flop, and pressing the "NO" switch clears it.

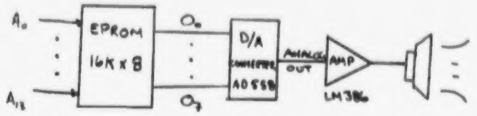
Pressing either the "YES" or "NO" switch causes AND1 to output a low which sets FF2. The "1" from FF2 is anded with the 555 timer output making the clock input to the counters an 8 KHz wave. The counters are now enabled to count. The outputs of the counters are routed to the address inputs of the EPROM.

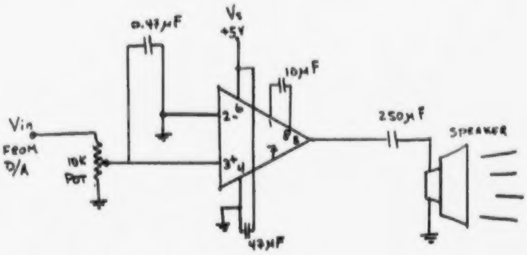
The counters will continue to count until A12 transitions from a high to a low (i.e. the outputs go from 1111111111111 to 0000000000000). A12 is connected to the clock input of FF3. At the 1 to 0 transition of A12, FF3 will change state, clocking F2 which then will send a zero to AND2, effectively disconnecting the counters from the 555 timer.

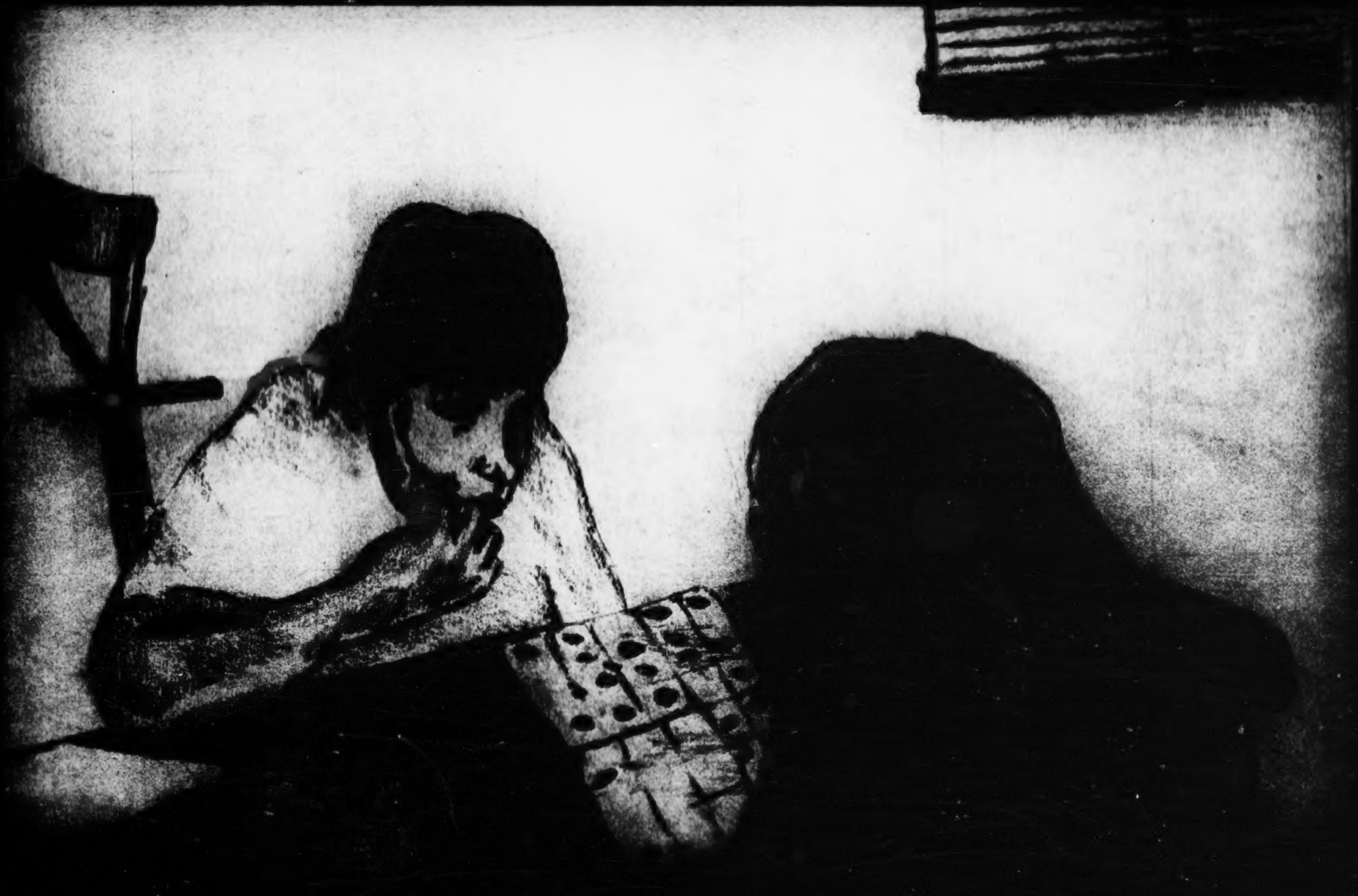
The eight outputs from the EPROM are fed into an AD558 Digital to Analog converter to convert the digital signal back into analog form. An LM386 is used to amplify this signal and drive a speaker.

The "Yes"-"No" talker costs approximately thirty-five dollars ($35) to build. It may be used by a people with a wide range of abilities. Its operation is extremely simple allowing even a moderately to severely retarded non-speaking person to use the device effectively.









CHAPTER 8

TEXAS A&M UNIVERSITY
COLLEGE OF ENGINEERING
BIOENGINEERING PROGRAM
COLLEGE STATION, TEXAS 77843

Principal Investigators:

William A. Hyman (409) 845-5532

Gerald E. Miller (409) 845-5532

Audiovisual Stimulation Center

Designers: Gayle Karamonos, Teresa Appeddu, and Michael Thom
Therapist: Greta Cheery, Children's Center for Developmental Therapy
Supervising Professors: William Hyman and Gerald Miller
Bioengineering Program
Texas A&M University
College Station, Texas 77843

INTRODUCTION

The midline reach development center was built to serve as a rehabilitation aid for the correction of asymmetrical tonic neck reflex, the inability to keep one's head facing forward while moving the arms inward. The objective was to provide a high degree of visual stiumlation at the midline so that the child would be attracted toward a central orientation when the required arm motion was initiated. The device consists of a plexiglass box mounted on adjustable PVC legs. The visual feedbacks include an arrangement of Christmas tree lights and an elctronically controlled mirror which becomes reflective when power is applied. Audio feedback is provided by a standard cassette deck which provides the flexibility of playing any desired music. The child operates the system by pressing control arms in toward the midline. The therapist can select any combination of outputs as well as choose whether both levers must be activated, either lever or only the left or right levers.

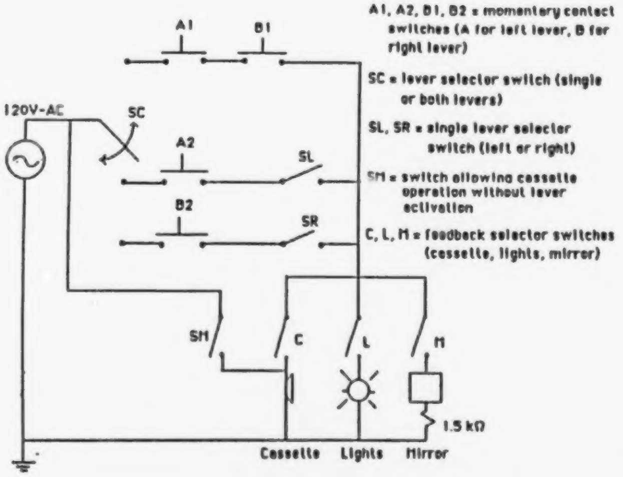
SUMMARY OF IMPACT

This device has been succesfully used at the Center to provide the desired therapy and physical response by the user. It provides therapy for children from infancy to age three who have Cerebral Palsy and experience asymmetrical tonic neck reflex. The therapy is given to the children during their Center visits for 15 to 30 minutes weekly. Initially, the therapist provides light and music stimulation to develop the child's head midline orientation. As motor development occurs, the therapist incorporates lever activation of the stimuli to train the child to accomplish lateral arm movement to the midline with the desired head orientation. The therapists have reported very positive results in correcting abnormal midline reflex. This therapy will eventually allow the children to maintain proper midline orientation/movement leading to future development of neuromuscular reflexes for higher skills such as eating, dressing and writing.

TECHNICAL DESCRIPTION

The midline development center's main component is a rectangular plexiglass box measuring 28"x22"x6". The box contains the circuitry, output components, and a mounting for the mechanical components. The box is supported by adjustable legs made of nesting 1" and 1 1/4" PVC pipe. The inner, top pipe is attached to the box by 1" metal flanges. The feedback stimuli are provided through lights, a cassette player, and an electronic shutter which exposes a mirror. The shutter (Edmund Scientific) is a plastic sheet whose opacity can be varied by the application of voltage. An external speaker which faces the child was interfaced to the cassette player. The player itself is mounted in the top of the box which provides complete access to its controls for the therapist. An additional switch is provided which allows continuos use of the cassette player if background music is desired. Also on the top are switches for the therapist which are used to select which stimuli are to be active, and the required input lever motions. The latter can be selected to be both simultaneously, either one, or only the left or only the right. The entire system is powered by 120 VAC.

The child's input levers are 12" by 1 1/2" plexiglass padels affixed by metal hinges to 3" long, square, hollow plastic tubes suspended from the bottom of the box with L-brackets. The tubes pivot on the L-brackets which provides adjustment of the angle of the levers, and thereby the distance between them. The free ends of the levers are covered with colorful toy soldier pads. The levers make contact with push button switches on the plastic tubes.


A1
B1
120V-AC
SC
A2
SL
B2
SR
SM
C
L
M
1.5 kΩ
Cassette
Lights
Mirror
A1, A2, B1, B2 = momentary contact switches (A for left lever, B for right lever)
SC = lever selector switch (single or both levers)
SL, SR = single lever selector switch (left or right)
SM = switch allowing cassette operation without lever activation
C, L, M = feedback selector switches (cassette, lights, mirror)

Electrical Circuitry for Midline Reach Development Center.

Stationary Exercise Tricycle

Designers: Steven Miller and Mark Pfaff
Therapist: Greta Cheery, Children's Center for Developmental Therapy
Supervising Professors: William Hyman and Gerald Miller
Bioengineering Program
Texas A&M University
College Station, Texas 77843-3120

INTRODUCTION

This project provides a stationary tricycle for therapeutic exercise. The resistance can be varied by adjusting a roller which presses against the front wheel. Rotation of the front wheel also drives a moving electronic display of lights on the wheels of a motorcycle figure. The objective of this device is to provide an exercise program using a familiar child's toy, while also giving the user a visual feedback which encourages compliance with the exercise goal.

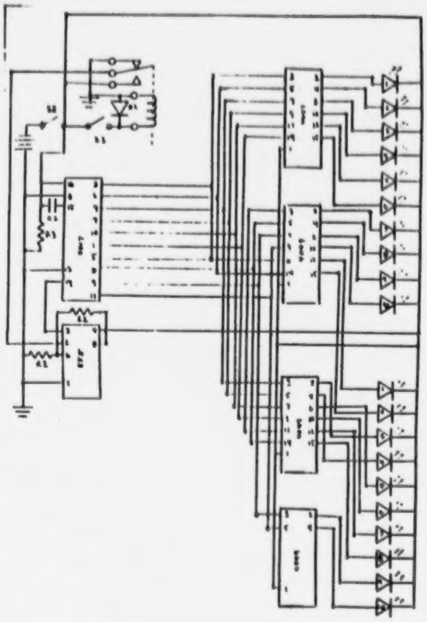
SUMMARY OF IMPACT

A number of the clients of the Children's Center for Developmental Therapy are unable to provide enough leg force to pedal a standard tricycle. For other clients a stationary exercise system was desired in which the work required to pedal could be normal, or above normal. For each group it was desired to use an apparatus that the child would be familiar with, and one in which the physical skills learned and developed could be directly translated into routine play. The design criteria was therefore to provide an exercise system based on a standard tricycle which would provide a leg strengthening exercise regimen in which the resistance to pedaling could be varied from very low, through normal, to above normal. A further goal was to provide a stimulating visual display so that pedaling in place would not be overly oring. Since this device is for permanent use in the facility, a number of children have benefited from its use and the therapists have accepted the system as a routine and desirable addition to their physical therapy regimen.

TEHNICAL DESCRIPTION

The basic components of this system are a standard, commercial child's tricycle, an adjustable mechanical resistance unit adopted from a commercial bicycle trainer, a custom base, a hand painted display unit, and a stepping circuit which drives a sequential display of LED's located on the wheels of a motorcycle figure. The full tricycle was used, including the back wheels, for convenience and to retain the familiarity of the device. The tricycle is mounted to the 1/2" plywood base with four U bolts around the rear axle and a support pipe which extends from under the seat to the base. The resistance unit is also secured to the base with U bolts. The base is strengethened with a skirt of 2x4's and the entire unit is on casters so that it can be easily moved. The display unit is contructed of plywood and is secured to the base. The rear of the display unit has an access door to the circuitry and batteries. The wooden base and the display unit are covered with carpeting to improve the appearance of the system and provide a cushioned, splinter free surface.

The front of the display unit has a picture of a motorcycle which was hand painted on white plexiglass. The main power switch is also on the front of the display. Each wheel of the motorcycle has 10 LED's uniformily placed around the rim of the wheel. The front wheel of the tricycle has four equally spaced horizontal pegs which can close a momemtary switch which extends from the bottom of the display unit. The switch provides input to a stepping circuit. Each closure of the switch advances by one which LED is enabled. The two Led's which are lighted at any time are set at matching positions around the rim of the motorcycle "wheels". Since the LED's advance once per switch closure, and the switch is closed four times per revolution, the LED's advance four steps per revolution. The use of four pegs was selected so that even a modest pedaling speed would produce a lively display. The stepping circuit used in this application is illustrated below. An alternative, and much simpler, display could be substituted in which a single light, group of lights, or other output device was activated with each switch closure. This design is available at the center for parents who would like to duplicate the device using a simple circuit.



CIRCUIT DIAGRAM

An Auditory Stimulation System to Interface to an Exercise Bicycle for the Visually Impaired

Designers: Edgar Chucle, Mark Sullivan, Robert Stonestreet
Disabled Coordinator: Marcia Willson, Denton State School
Texas Department of Mental Health and Mental Retardation
Supervising Professors: Gerald Miller and William Hyman
Bioengineering Program
Texas A&M University
College Station, TX 77843-3120

INTRODUCTION

A positive feedback music system was developed to motivate visually impaired individuals to utilize an exercise bicycle in the Sullivan Center at the Denton State School. The system provided music from a tape player once the bicycle wheel was set in motion. The system can also be set so that very little motion up to large wheel motion would elicit the music feedback.

SUMMARY OF IMPACT

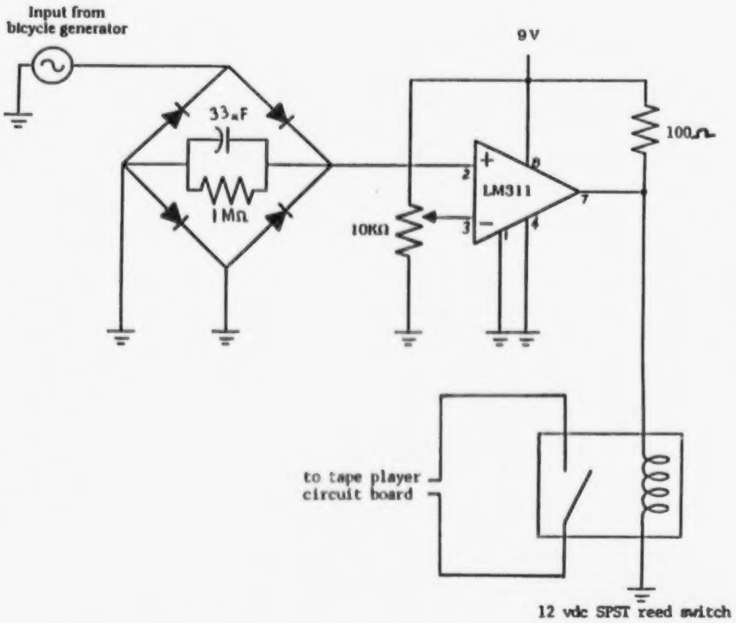
An exercise bicycle is utilized to increase mobility and enhance muscle tone in disabled individuals. However, those individuals with visual impairments who have never seen or experienced an exercise bicycle may feel disoriented and ill at ease in its use. The use of positive feedback through music allows a visually impaired individual to feel more comfortable on the bicycle and to be motivated in its use. Only when the bicycle is operating does the music play. Thus, when the client stops pedaling, the music stops as well. The system can be adjusted to require a particular level of pedaling before the music is initiated, thus motivating the client to pedal harder to achieve the desired music feedback.

TECHNICAL DESCRIPTION

The system utilizes a standard battery operated tape player, bicycle generator, and supporting electronics. The generator voltage is rectified into a DC voltage and compared to a reference voltage in a comparitor circuit. The reference voltage can be changed by the user by turning a potentiometer knob. This allows the system to be tuned to a particular rate of wheel movement and would require the client to pedal at a certain rate to achieve the music output from the tape player.

When the generator voltage exceeds the reference voltage, a relay switch is closed which allows power to be supplied to the tape player. The tape player is always in the "play" mode, but will only operate when the relay switch is closed.

The components include a battery operated tape player, LM311 comparitor, full wave bridge rectifier, reed relay, resistors, 100K trim potentiometer, capacitor, slide switch, mounting box, battery holder, and 9 volt battery. A circuit diagram is shown below. The system components cost $100.


Input from bicycle generator
9V
33µF
1MΩ
100Ω
LM311
10KΩ
2
3
8
7
1
4
+
−
to tape player circuit board
12 vdc SPST reed switch

A Sensory Stimulation System for the Profoundly Handicapped to Teach Cause and Effect Relationships

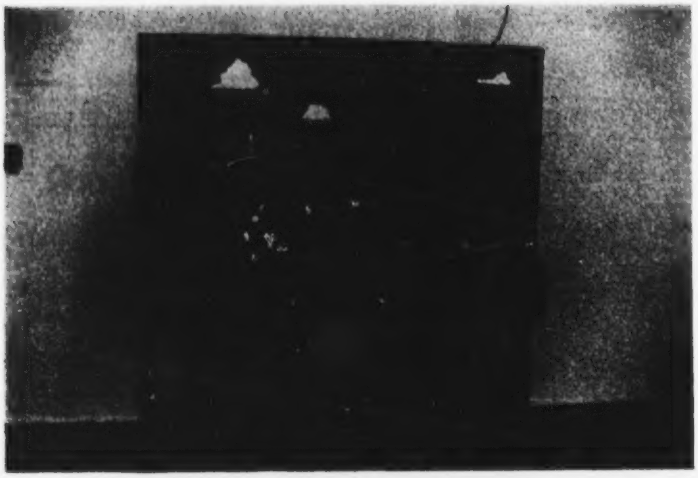
Designers: Mark Benden, Rebecca Huggins, Bill Pierce, Ed Thomas
Disabled Coordinator: Marcia Willson, Denton State School
Texas Department of Mental Health and Mental Retardation
Supervising Professors: Gerald Miller and William Hyman
Bioengineering Program
Texas A&M University
College Station, TX 77843-3120

INTRODUCTION

A large portable sensory stimulation wall was designed to teach cause and effect relationships to profoundly handicapped individuals at the Denton State School. The system acted as a stimulation and training aid which could be operated by handicapped clients under the supervision of staff and therapists. The system had to be sufficiently dazzling in order to motivate these individuals to utilize the system and to remain attentive. The cause and effect relationships had to be direct and provide considerable auditory, visual and motion feedback to the clients.

SUMMARY OF IMPACT

Many profoundly handicapped individuals who are served at state rehabilitation facilities are self centered and dwell in their own worlds. It is difficult to motivate these individuals to function in even the simplest terms in such areas as communication, ambulation and cognition. A system which can jointly stimulate and educate such individuals would be of considerable benefit. Such a system was developed and consisted of multiple cause/effect stations blended together into a normal street scene. The overall effect was to arouse the profoundly disabled clients into participating in the system operation, train them in the use of switches to elicit a cause/effect relationship and familiarize them with an everyday scene such as that on a busy city street.



TECHNICAL DESCRIPTION

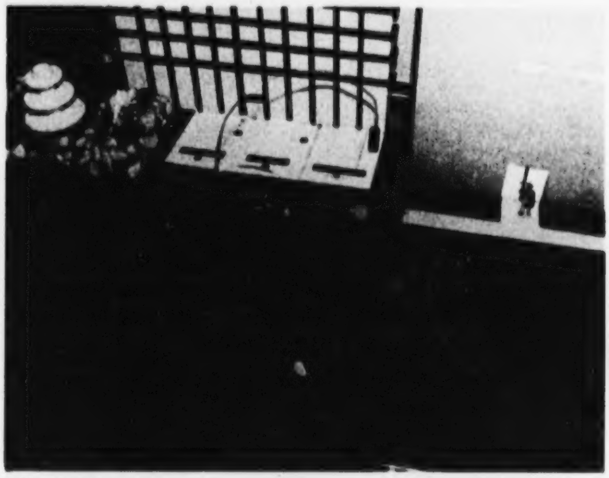
The overall system was built onto a portable wooden platform which measured 6 feet wide, 6 feet high and 2.5 feet deep. The frame was built from 3/4" plywood with 2 by 4" and 2 by 6" support beams. The overall size was similar to that of a portable blackboard. A street scene was displayed on the front of the wall by means of various background paintings as well as with foreground 3-D objects and devices which provided auditory, visual and motion feedback (see figure).

The various feedback stations included two buildings which could light up, street lights which could light up, a subway car which could move back and forth along a submerged (underground) track (seen via a plexiglass panel), a police car whose siren could blair and whose lights could flash, a street fountain which could spew water in the air (a few inches), and a helicopter which could rotate its blades and project taped aircraft sounds.

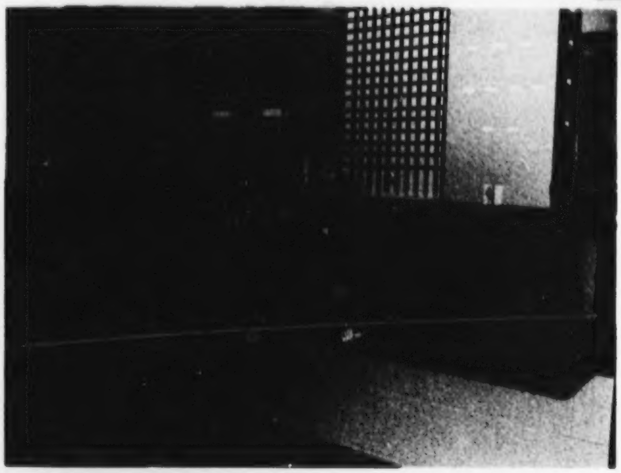
All of these devices can operate via switches mounted on the wall itself. A jack input was provided next to each switch. Remote, box mounted, latching switches could be attached via the jack and extension wire to control any or all devices from 10 feet away. Thus, the clients could operate a station at the wall or remotely. Since there are several stations, many clients could utilize the system simultaneously.

The devices were DC powered but were connected to AC line power via transformers hidden in panels in the rear of the unit. The system was built on casters to allow it to be moved about. The depth is 2.5 feet to allow it to travel through doorways.

DETAIL - ROCKER SWITCHES FOR EACH DEVICE



DETAIL - EXTERNAL SWITCHES



DETAIL - "SUBWAY" WITH SELF REVERSING

145

Custom Backlit Wheelchair Tray

Designers: Steven Gard and Scott Probasco
Therapist: Irma Riojas, Children's Center for Developmental Therapy
Supervising Professors: William Hyman and Gerald Miller
Bioengineering Program
Texas A&M University
College Station, Texas 77843-3120

INTRODUCTION

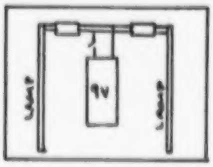
The wheelchair tray in this design offers several features which are not available in commercial devices. These include custom fitting to an ultralight wheelchair, easy on/off, high edges to help retain toys or other objects being used on the tray, and backlighting so that concentrated but diffuse lighting is provided to a low vision user. The angle of the tray is also readily adjusted. An additional design criteria was that the design should be reproducible by parents or others with a minimum of wood working skills. Complete working drawings are provided by the Center to interested parents.

SUMMARY OF IMPACT

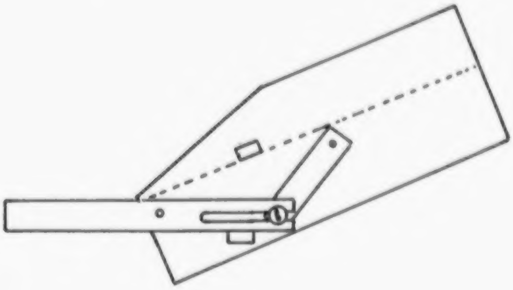
This device provides a work and play space for wheelchair constrained children with low vision. It is often not convenient or desirable to reposition some potential users of this device and therefore the wheelchair mount, and easy portability are distinct advantages. It has been used at the Center for several clients both during waiting periods and directly in occupational and speech therapy situations utilizing object manipulation.

TECHNICAL DESCRIPTION

The basic unit was constructed using plywood for the back, sides and bottom. The tray top is translucent white plexiglass which provides a diffuse and evenly lit surface. The plexiglass tray slides into retaining grooves in the two sides from the rear and fits into a similar groove in the front surface. The tray is retained in the unit by a rotating clip at the rear. This provides easy access to the lights and batteries. The lighting system was adapted from two commercial flourescent single tube flashlights. These flashlights were disassembled to obtain the tubes, tube holders and curcuitry. A 6xD cell battery holder provides power to both lamps. An on/off rocker switch is provided in the bottom of the unit. The arms of the tray were also built from plywood. A simple cup is provided at the ends of the arms which mate with the wheelchair arms were they are secured with velcro straps. Rotation of the tray is provided through the use of two pivot points on the sides of the unit, with a slot in the arms engaging a screw attached to a 1" piece of flat steel stock. The screw is secured with a wing nut. This provides more secure positioning than could be obtained with a single pivot point. Further details of the constuction are shown in the accompaning figures. Additional information is available from the supervisors.



CIRCUIT DIAGRAM



CONSTRUCTION DETAIL OF TILT MECHANISM

A Cane Swing Training Ramp for the Visually Impaired

Designers: William Pierce and Winston Marshall
Disabled Coordinator: Marcia Willson, Denton State School
Texas Department of Mental Health and Mental Retardation
Supervising Professors: Gerald Miller and William Hyman
Bioengineering Program
Texas A&M University
College Station, TX 77843-3120

INTRODUCTION

Many clients at the Sullivan Center for the Visually Impaired at the Denton State School are children and young adults who have never learned to use a cane properly during walking. A cane training system was designed to allow such individuals to learn the proper cane swinging technique during walking. The training could be accomplished under the tutelage of therapists and staff. A modified cane with a stopper on the bottom was developed for insertion into the training walkway.

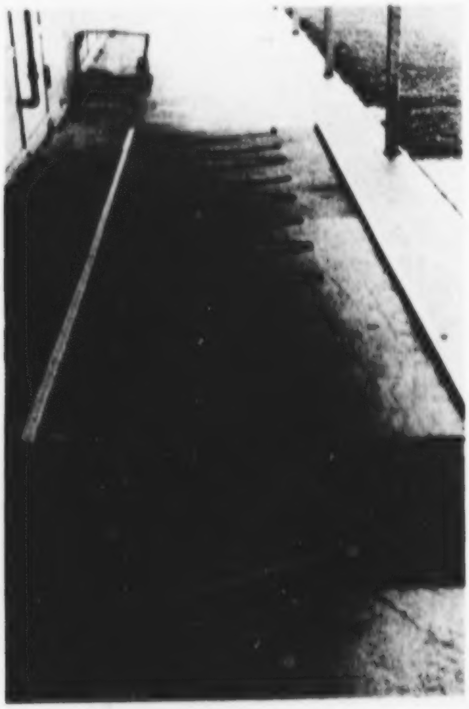


Figure 1 ASSEMBLED WALKWAY

SUMMARY OF IMPACT

Individuals who have been recently blinded and who have not been trained in the proper use of a cane during ambulation are severely limited in their ability to be reasonably independent of their therapists and support staff. In addition, many individuals who suffer from multiple disabilities may have never been taught the proper use of a cane as well.

A training system was developed to allow such individuals to be instructed and to practice in the proper use of a cane during walking. The system utilized a walkway with a sinusoidal cutout and a modified cane with a hinged disk on the bottom. During ambulation along the walkway, the client would move the cane along the sinusoidal cutout which would enforce the side to side movement of a cane required during normal ambulation. Thus, disabled clients could learn the proper method of cane swing which would allow them to move freely throughout the facility.

TECHNICAL DESCRIPTION

The cane movement training system consisted of a 16 foot by 4 foot walkway which was developed in four sections for ease of transportation, storage and setup. There were two separate ramps placed at each end to allow the clients to gradually step onto the walkway. The walkway was built from 3/4" plywood with standard 2 by 4 posts used to create a frame. A sinusoidal path was cut into the plywood sheeting, 3/4" wide, with the sinusoid repeating every 2 feet.

The four pieces were built so that two sections would lay on top of the other sections. Handles were placed on each side of all pieces for easy manipulation and clasps were placed on the sides to attach all four pieces together during use (see figure). A raised 2 by 4" rail was placed on either side of the walkway to prevent a client from accidently walking off the side of the path. A standard cane was modified by attaching a hinged plexiglass disk to the bottom. The materials, including wood, hardware, plexiglass, sanding and painting materials cost $200.

A client would enter the walkway through one ramp, place the training cane into a hole in the ramp (which was aligned with the walkway cutout), and begin to walk down the path while moving the cane in front. The cutout would allow the cane to traverse a side to side movement, typical of normal cane motion during walking.

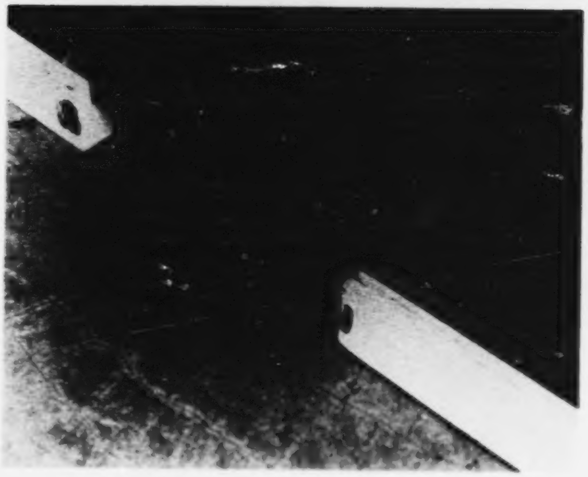


Figure 3 ASSEMBLY DETAIL - LATCHES

Figure 2 WALKWAY COMPONENTS

Figure 4 ACCESS HOLE FOR CANE TIP DISK

Keyboard Overlay and Software for Music Therapy

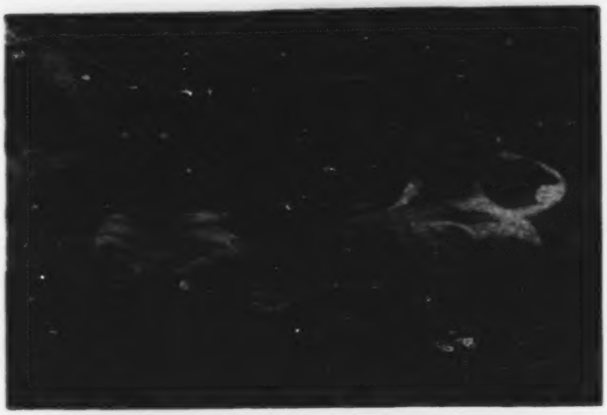
Designer: Jay Harrison
Client: Richmond State School
Texas Department of Mental Health and Mental Retardation
Supervising Professors: William Hyman and Gerald Miller
Bioengineering Program
Texas A&M University
College Station, Texas 77843-3120

INTRODUCTION

This system consists of a computer keyboard overlay and custom music training software. The overlay easily attaches to a standard computer keyboard, hiding the original keys, and providing the appearance of a simulated piano keyboard. Pressing the appropriate locations on this cover is directly translated into pressing one or more underlying keys. Through software control groups of neighboring keys perform the same function. The objective of this design is to limit the keyboard appearance to only a small number of contact areas. The same design, with different patterns, can be used for other commercial or custom software for which only a limited number of keyboard entries are required. The advantage of this design is that it is of mimimal cost, is highly flexible in its application, and it does not require an electronic interface. The accompaning music software was designed to provide training in basic music skills such as tone and notation recognition.

SUMMARY OF IMPACT

The original user of this system was a residential client of the Richmond State School whose only communication or physical output is through the use of a head pointer. An earliar design project had produced an adjustable wheelchair tray which accommodated a voice synthesizer. It was subsequently suggested that an electronic musical keyboard could also be accommodated on the tray system and that such a device would provide this woman with a highly capable and multifunctional system for a creative outlet and self entertainment. When such a keyboard was provided, the client was immediately able to understand the necessary action, and she quickly developed capability to use this instrument. It was therefore decided that some musical training would be appropriate that could be delivered in a very limited physical format, but which could be directly used by the client. The result of this need was the system described here.



SYSTEM OVERVIEW SHOWING KEYBOARD COVER

It is noteworthy that the original user of this project is severely involved physically, non- verbal, and a fulltime resident of the School. Her prospects for significant habilitation to the external world are very limited, and she therefore requires a complete regimen of institutional activities. The fact that she demonstrates a reasonable level of cognitive ability further challenges the staff to occupy her with things that will be both entertaining and beneficial. While music therapy is a long recognized specialty, its use with severly involved individuals has been limited by the user's ability to interact with a musical device. The enormous capability, at modest cost, in a small package, makes the modern electronic musical keyboard ideal to address this need. In this case the use of such a keyboard suggested that additional music education would be an appropriate activity for this individual. The system also provides an orientation toward computer operations which could be expanded into other activities.

TECHNICAL DESCRIPTION

The keyboard portion of this system consists of a rubber sheet stretched over dowels at each end. The dowels are secured in a wooden frame which fits over a standard computer keyboard. Areas corresponding to piano keys and areas for related functions are indicated on the top of the rubber sheet. Pressing the rubber sheet with a head stick, other object, hand or finger, directly presses the underlying keys. Through the software all of the computer keyboard keys under an indicated area perform the same function. This allows for large functional contact areas, while masking the rest of the keyboard. The basic design used here could be adopted to any other commercial or custom software which required the use of a limited number of keys or inputs from the keyboard.

The software provides a series of musical educational activites in the form of games. Each game displays the music staff, locations of notes, instructions, prompts after wronq answers, and musical tones corresponding to the keys pressed. The program is written in Basic using high resolution graphics.

DETAIL OF SCREEN DISPLAY

A Telephone Answering Training System for the Cognitively Handicapped

Designers: Steven Gard, Gloria Dominguez, Scott Probasco
Disabled Coordinator: Sara Atkins, Gulf Coast (TX) MHMRA
Supervising Professors: Gerald Miller and William Hyman
Bioengineering Program
Texas A&M University
College Station, TX 77843-3120

INTRODUCTION

A telephone conversation training system was developed to instruct cognitively disabled individuals to communicate to their doctor or to a police emergency number. The system consisted of a push button telephone, tape player and supporting electronics. The system was portable and battery powered such that a client could utilize the system at a training facility or at home.

SUMMARY OF IMPACT

Many cognitively disabled individuals who live at home with their families are at times left alone. Even those disabled individuals living in semi-independent living facilities are at times left unsupervised. Should the need arise for a medical or other emergency, these individuals may not have the appropriate skills to contact or communicate with the appropriate authorities.

A training system was developed to allow such individuals to learn how to dial the telephone and speak to either their physician (at the doctors office) or with the police (via 911). Once properly trained, these individuals can be more safely left unattended and can lead a more independent lifestyle.

TECHNICAL DESCRIPTION

The system consists of a push button telephone, a tape player, and supporting electronics. The system operates under the direction of a client user. Once the receiver is picked up, a dial tone is heard. This is accessed from the telephone circuitry. When the user "calls" a seven digit number, a tape of a ringing phone line is heard through the receiver. After two rings, a conversation begins between the tape player and the disabled user. There is a pre-recorded conversation on the tape system which is activated in sections through the VOX input. As the disabled speaker pauses after speaking, the tape player then plays its portion of the conversation. The "conversation" simulates a situation where the client desires to schedule an appointment with the physician. A different tape was developed for the police 911 number. In that case, the user "calls" 911 and is led through a conversation with the "police". A switch on the side of the unit is used to select either 911 or a seven digit number. The tape player automatically rewinds the tape to the beginning of the conversation after each session. The conversations can be tailored to an individual client's needs by allowing a therapist or family member to record the simulated conversation. A training manual was developed for that purpose and to assist in operation of the system. The system is powered by 4 "C" cell batteries.

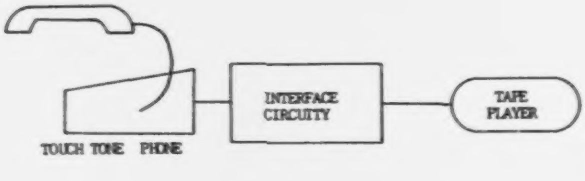


Figure 1 SYSTEM OVERVIEW

The system circuitry is shown below. The parts consist of a counter, AND gate, timers, OR gate, NOT gate, NAND gate, analog MUX, 741 quad amps, operational amps, relays, resistors and capacitors. The dial tone circuit is independent of the other circuits and functions only when the counter is set to zero. The touch tones are always active and are monitored through the OR gate, debounced, and used to start the timer. When the appropriate count is reached (from the switch - 3 or 7 digits), the multiplexer provides power to the relay circuit which causes the pause loop allowing the tape player to operate. The microphone input is amplified and sent to a RC timer and on to a comparitor. When the comparitor is active, the pause circuit is activated, which stops the tape player. Thus, while the user is speaking, the tape player pauses; when the user stops speaking, the comparitor goes "low" and the pause control is inactivated, allowing the tape player to "speak" its part of the conversation.

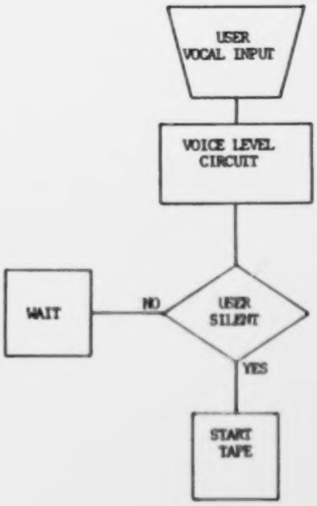

USER
VOCAL INPUT
VOICE LEVEL
CIRCUIT
WAIT
NO
USER
SILENT
YES
START
TAPE

Figure 3 CONVERSATION MODE

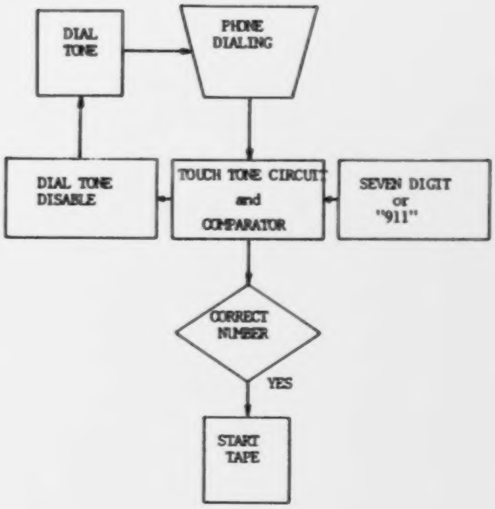

DIAL
TONE
PHONE
DIALING
DIAL TONE
DISABLE
TOUCH TONE CIRCUIT
and
COMPARATOR
SEVEN DIGIT
or
"911"
CORRECT
NUMBER
YES
START
TAPE

Figure 2 INITIATION MODE

Vertical Pole Walkway

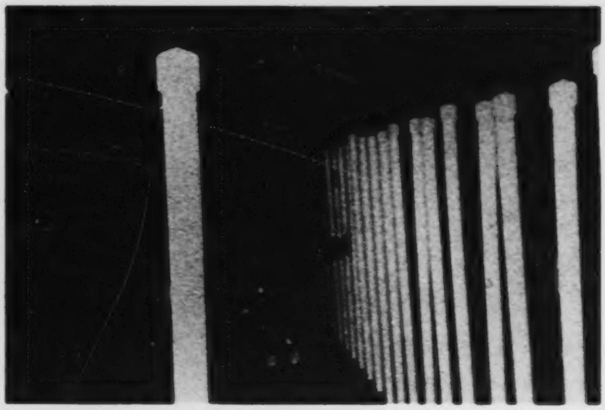
Designers: Paul Slater and Rainer Fink
Therapist: Greta Cheery, Children's Center for Developmental Therapy
Supervising Professors: William Hyman and Gerald Miller
Bioengineering Program
Texas A&M University
College Station, Texas 77843-3120

INTRODUCTION

A standard device in physical therapy is parrallel bars which are used to provide manual support during training or retraining in walking. One drawback of parrallel bars is that the horizontal bars can provide continuous support which reduces the need for the user to provide proper weight shifting as they ambulate. The device described here substitutes two rows of vertical bars for the two horizontal bars. With vertical bars hand support must be released and repositioned as the user progresses down the walkway, more closely simulating unsupported walking. The system also provides for the therapist to energize lights at the top of each pole. These lights can be used to provide a moving target as well as encourage a head up posture.

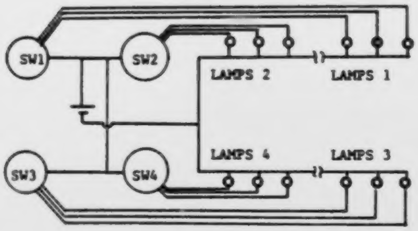
SUMMARY OF IMPACT

This device is a permanent piece of equipment in the physical therapy department of the Center and therefore serves many clients. It can be used in place of horizontal parallel bar training, or after the use of horizontal bars becomes too easy for the client, but support is still required. Experience with this device to date has demonstrated that it provides a very useful transition or adjunct in ambulation training.

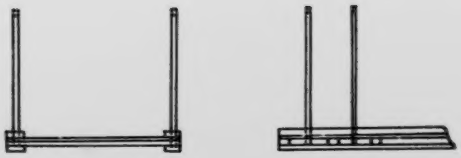


TECHNICAL DESCRIPTION

The system consists of a wooden base with side stuctures which provide support for two rows of 24 equally spaced vertical poles. The base of the walkway is 3/4" plywood and side rails are assembled from 2x4's above and below the walkway deck. Additional 2x4's provide cross supports under the walkway for added strength. The poles are made of PVC pipe which fit into holes which penetrate the side rails. The top of each pole is capped with a standard PVC end piece into which is fitted a small lamp. Each lamp is wired to a control box and a power source consisting of a large lantern battery. The wires are contained within the PVC pipe and under the walkway so that there are no exposed wires. The control box contains four multiposition switches, two for each side of the walkway. For each side one switch controls sequentially the first 12 lights and the second switch controls the next 12 lights. Typically these swiches are used sequentially so that one lamp is lit on each side in a progressive manner as the user traverses the walkway. Use of the lights is optional. Selected poles can also be removed and the wiring unplugged so that the spacing between the poles can be increased in descrete increments. Construction and wiring details are provided in the accompaning figures.



WIRING SCHEMATIC



CONSTRUCTION DETAIL

Hand and Arm Exercise Systems

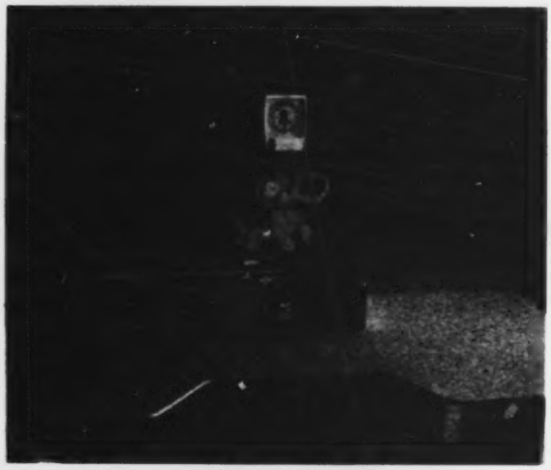
Designers: Larry Carrier, Rebecca Huggins, Christy Tock, Florence Dabney,
William Pierce and Cecilia Duarte
Client: Children's Center for Developmental Therapy
Supervising Professors: William Hyman and Gerald Miller
Bioengineering Program
Texas A&M University
College Station, Texas 77843-3120

INTRODUCTION

Two projects for occupational therapy of a child's hand are described here. The first involves a hand squeeze motion with the child's interface being a rubber bulb. The second is for finger extension. In it the child raps their hands around a bar and the required motion is to extend the fingers upward toward a hand flat position. In each case the exercise device is initially attractive to the user as well as providing a strong visual or audio- visual feedback when the desired force or extension is achieved. Each apparatus is also adjustable by the therapist to the physical condition of the user. The feedback in the hand squeeze device is an array of LED's which flash when a preset pressure in the bulb is achieved. This devise also provides a continuous visual indication of the pressure obtained during the exercise and a therapist override which can be used to activate the flashing LED's as a reward for a strong, but subtrigger grip, by the user. The hand extension device triggers a battery powered mechanical toy each time the desired extension is obtained. The particular toy used here provides physical motion as well as musical sounds, although any battery powered toy could be substituted.

SUMMARY OF IMPACT

A continuing challenge in occupational and physical therapy for young children, especially in the case of developmental disabilities, is appropriate motivation to the child to perform the desired activity. In order to achieve this goal an apparatus which is attractive and entertaining can add to the user's motivation to participate. In each of the devices described here the therapists defined the action required and the designer's task was to incorrporate these actions into a suitably stimulating device. In addition it was required that the devices be easily portable so that they could be used both at the Center and in outreach programs. Both of these devices have found continuous use by the Center's staff and clients following their delivery. Their use has demonstrated an increased ability to motivate the children requiring hand therapy to actively participate in the desired exercise.



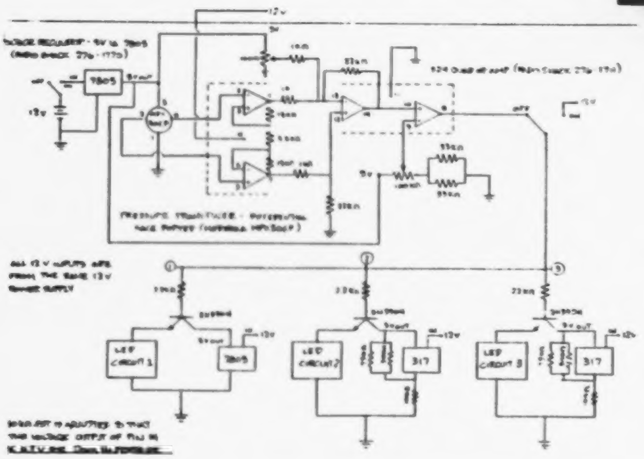
HAND SQUEEZE SYSTEM

TECHNICAL DESCRIPTION

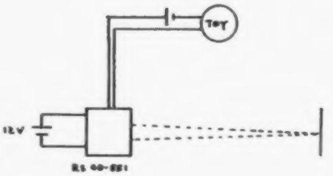
Hand Squeeze. The child's interface to the hand squeeze unit is a rubber bulb from a blood pressure appartus. The pressure generated in the bulb is displayed on an analog pressure guage and compared to a preset pressure goal using a pressure transducer (Motorola MPX50GP) and adjustable comparator circuit. The external appearance of the device is a highly decorated black plexiglass display unit incorporating the circuitry, manometer, calibrated pressure adjustment, therapist override switch, main power switch, and LED's. Self flashing LED's (e.g. Radio Shack 276- 030) and external flasher (Radio Shack 276-1705) driven LED's (e.g. Radio Shack 276-066) were used to provide a variety of colors and flashing performance. The entire unit is battery powered to enhance portability and safety. Twelve volts are provided using 8 AA batteries. The squeeze bulb is attached to the device with flexible tubing. These components, along with the manometer where obtained from a commercial home blood pressure unit (Sunbeam). A schematic of the mechanical and electronic circuitry is provided in the figure below.

Finger Extension. In this device the child initially grips a 1" diameter PVC pipe positioned at the open end of a plexiglass box. The hand grip has a central support and end disks to help keep the child's hands on the unit. The hand grip can be moved in and out and up and down to adjust its position relative to the pulsed infrared beam sensor (Radio Shack 49-551). When the child extends the fingers to break the infrared beam, the sensor closes an output switch which activates a battery powered toy located on top of the unit. As supplied, the sensor provides 3 seconds of output for a momentary interruption of the beam. The 3 second duration can be modified by changing a single capacitor in the sensor if desired. The sensor is battery powered. For portability the toy can be removed from the top and stored inside the box. A carrying strap is also provided since the unit is relatively bulky. A schematic of the component layout is provided in the figure below.

FINGER EXTENSION SYSTEM



CIRCUIT DIAGRAM - HAND SQUEEZE SYSTEM



SYSTEM DIAGRAM - FINGER EXTENSION SYSTEM

Applications of Stepping Circuits For Communication Devices

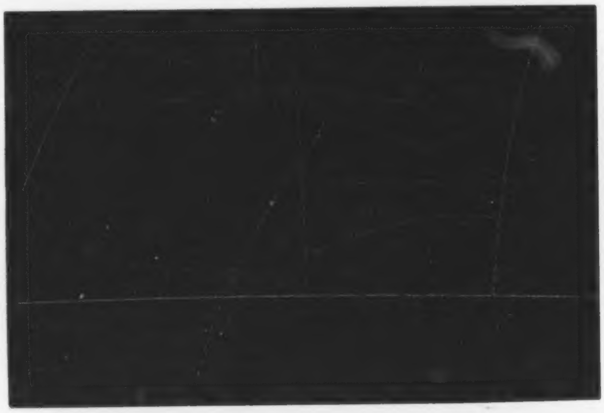
Designers: Fabian Pollo, Scott Probasco, Steven Gard,
Steven Miller, Winston Marshall, and Jacque Haynes
Clients: Children's Center for Development Therapy and
Harris County MHMRA
Supervising Professors: William Hyman and Gerald Miller
Bioengineering Program
Texas A&M University
College Station, Texas 77843-3120

INTRODUCTION

Many developmentally delayed children with limited motor function require technical aids for early training in communication skills, switch activation, cause and effect perception, and word picture association. Each of these needs can be met through the use of communication devices which emply a stepping circuit which allows successive closure of a single switch to step through a number of output selections. Three systems employing stepping circuits are described here. The first is a self contained unit with four compartments which have individual lights. As the single switch mounted on the unit is pressed, the lights are energized in turn. A toy or other object can be placed in each compartment, or a picture or word can be placed in front of a compartment in whcih case it would be back lit. In the second unit a single switch is connected by wire to an interface box. The interface unit allows the stepping circuit to be varied from one to four outputs before. Each possible output is jack connected to appropriate output units such as individual light boxes or battery operated toys to which a jack controlled power interrupt has been added. The third unit is for visual stimulation and consists of four groups of different colored LED's. As each group is energized a random twinkling of the lights in that group takes place. While the child uses only the single switch input, the therapists has available a control box which can also be used to step through the system. In addition the therapist can combine the light groups into different patterns, and/or select whether or not there is an all lights off step. The therapist can also energize one or more of the light groups independently from the output status of the stepping switch.

SUMMARY OF IMPACT

The develomentally delayed child has considerable need for devices that they can operate which are visually stimulating while providing training in higher levels skills associated with switch use, action/reaction, comprehension, and communication skills. The devices described here are for therapeutic rather than permanent use by individual clients. There are in continuos use at the respective agencies in working with a large number of children. They are easily portable and are also used by the therapists in outreach programs. The therapists have reported to us that these systems are enjoyed by the children using them whcih aids significantly in the therapeutic process. The therapists also believe that they are making a meaningful contribution the the development of these children that was not obtainable using other appraoches.

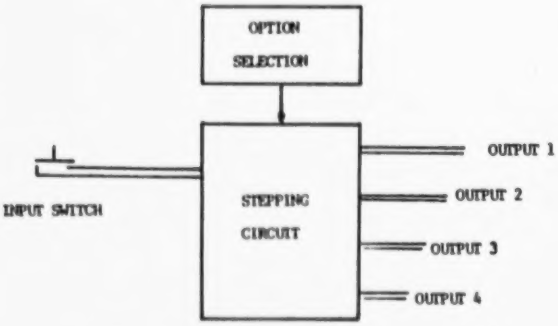


UNIT 1 - FOUR COMPARTMENT ITEM SELECTION

TECHNICAL DESCRIPTION

The outside of units one and three are constructed from plexiglass. The input switch in each case is a large flat plate which contacts a momentary push button switch underneath the plate. EWach unit is battery operated and uses the same stepping circuit design. Unit three folds for portability. The therapist switch unit for these unit uses toggle switches for mode control and a momentary push button switch for stepping these are mounted in a standard electronic project box.

For unit two the input switch is a momentary contact push button switch with an enlarged wooden button. It is mounted in a project box. The interface unit is also a project box. It contains the stepping circuitry, an on/off switch, and a rotary switch which is used to select one, two, three, or four output steps. In this application relays were used to interface the output from the stepping circuit to the switch closures within the jacks. This design was necessary to isolate the ouputs from the control circuitry since the output power requirements were not fully specified so that flexibility in type of output device was rtetained. The output devices illustrated contain colored lights and a jack input for connection to the interface box. These units are self powered with the interface box providing only a switch closure. With this design any other self powered device could be substituted such as a battery operated toy. If the chosen device did not have an external switch capability one could easily be added by hardwiring or by using an external interrupt loop in the battery compartment. Although three specific applications of stepping circuits are illustrated by these projects, the stepping circuit is a highly versitile interface and it has also been used by us in other similar projects. In one other case input via foot switch was provided for a client whose only useful volitional motor output was of a kicking nature.



NOTES: 1. Outputs powered from stepping circuit or switch closures using relays

2. Option Selections
Unit 2: One, two, three or four outputs is switch selectable
Unit 3: Alternate stepping switch
Alternate individual ouput switches
Pattern alteration

Figure 1 GENERIC SYSTEM DESIGN

UNIT 2 - STEPPING SWITCH WITH ONE, TWO, THREE OR FOUR OUTPUTS

UNIT 3 - VISUAL STIMULATION SYSTEM

Communications Devices for the Physically and Cognitively Impaired

Designers: Fabian Pollo, George Tures, Camie Erickson, Scott Probasco
Coordinating Facilities: Richmond State School, Denton State School
Texas Department of Mental Health and Mental Retardation
Supervising Professors: Gerald Miller and William Hyman
Bioengineering Program
Texas A&M University
College Station, TX 77843-3120

INTRODUCTION

A variety of communication devices were developed to aid children and young adults with cognitive and physical disabilities under the supervision of therapists and teachers. These devices allowed the disabled individuals to learn words, to piece together phrases, or to communicate at all for those clients who were completely non-communicative.

SUMMARY OF IMPACT

The ability of non-verbal disabled individuals to communicate affects many aspects of their daily lives. Tasks such as eating, drinking, bathroom, movement, need for staff intervention and many others may be severely limited if the client cannot function independently. The use of communication devices can serve two important purposes: it can allow the disabled clients to learn more about the process of communication, and it can serve as a vehicle for contact to a caregiver.

TECHNICAL DESCRIPTION

Several devices were designed for state schools and local school districts.
These included a 5 push button selection communication system, a push button form-a-phrase communication system, and a word/phrase key card communication system. These will be described separately.

Push Button Selection System

This system consisted of a plexiglass box with five large latching switches. Above each switch was a panel where a word or object (picture) could be placed. When a button is pushed, the panel lights up and a buzzer momentarily sounds. The device was utilized by non-verbal clients in two ways. Firstly, it could be used in conjunction with a therapist to learn to associate spoken words and phrases to objects or written words on the board. Secondly, it could be used to communicate needs (food, water, bathroom, etc) to a nearby caregiver without requiring the caregiver to continually hover around the client. This unit consisted of 1/4" plexiglass, SPST switches, 6 volt small lights, diodes, and 4 D cell batteries. The unit is shown in figure 1 below.

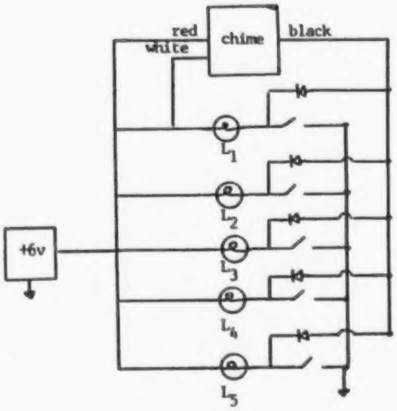


Figure 1 PUSH BUTTON ITEM SELECTION

Form-a-Phrase System

This system consisted of an aluminum chassis box with a series of pushbuttons and associated panels. On each panel was a word or phrase. When a button beside a word or phrase was pushed, then a light next to that panel would be lit. The client would light those words or phrases necessary to create a sentence or logical phrase. The choices were logically encoded within the box so that once a proper sequence was pushed, a chime would sound. If no proper sequence was pushed, there would be no sound and the system would be reset (by a reset switch). Such words and phrases as "please", "I", "thank", "want", "need", "help", "you", "a drink", "to go to the bathroom", and "me" were utilized. However, the therapist could use blank panels to create new words or phrases. Instructions were written to add new items for potential new encoded phrases or sentences. Thus, a client could create the sentence "I - want - to go to the bathroom", and the chime would sound. However, if "I - want - need - me" were pushed, there would be no sound produced, since that phrase is not appropriate.

This system consisted of two 7" by 10" chassis boxes, a hinge, cabinet latch, handle, panel mount rocker switches, latching push button switches, LED's, PC board, chime chip, and a 9 volt battery and clip. The unit schematic is shown in figure 2.

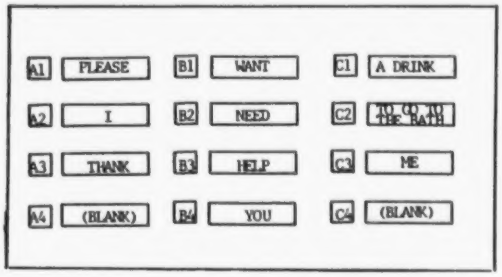


Figure 2a FORM-A-PHRASE USER INTERFACE

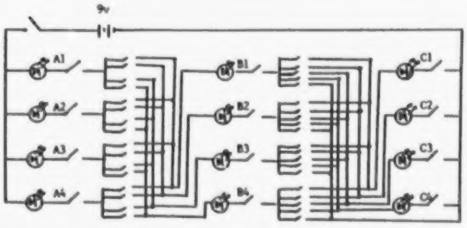


Figure 2b FORM-A-PHRASE CIRCUIT DIAGRAM

Key Card Communication System

This unit consisted of a wood box with 12 buttons and associated LED's and panels. On each panel would be a removeable word or picture. Below each light/panel on the side of the box was an associated slot for insertion of a key card. Thus, there were also 12 slots; one for each light. The key cards would also have a word or object on the card. Thus, if there was a word on the card, there would be an associated object on the panel above a light, so that the client could associate words with objects. Or there would be words on both the card and light panel to allow simple communication and sentence structure.

When a card is placed in its proper slot, the associated light would be lit and stay lit until a master reset switch is thrown. If the card were not placed in its proper slot, no light would be lit (each card is encoded so that it only corresponds to a single slot and associated light and panel). The electronics of this system consisted of momentary push button switches, an on/off button, LED's, 7400 NAND gates, IC sockets, PC boards, 9 volt battery and holder, a 5 volt-1 amp voltage regulator, and various resistors. The cards were plastic with encoded notches to push a coded set of inlaid switches inside each slot. The unit is depicted in figure 3 below.

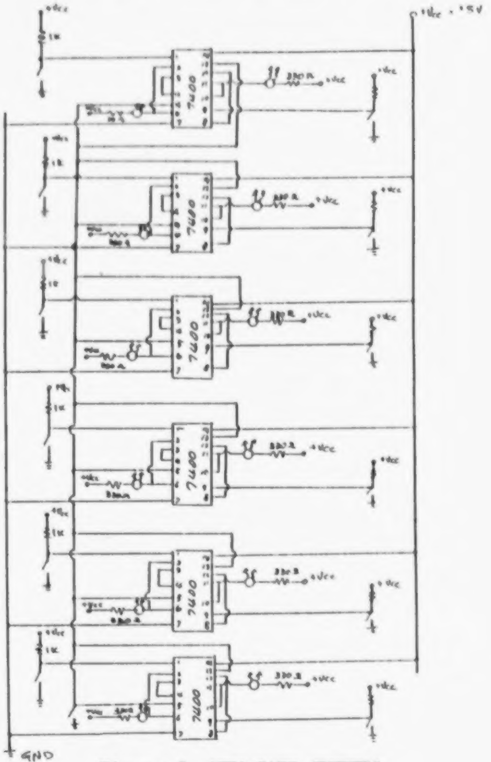


Figure 3 KEY CARD SYSTEM

A Modified Motorized Miniature Jeep for Pre-training of Children in the Use of Joystick Controls

Designers: Scott Probasco and Fabian Pollo
Disabled Coordinator: Donna Honea, Harris County (TX) MHMRA
Supervising Professors: Gerald Miller and William Hyman
Bioengineering Program
Texas A&M University
College Station, TX 77843-3120

INTRODUCTION

A training system for physically handicapped young children was developed to teach them the use of a joystick controller so that they could later operate a motorized wheelchair control. The joystick trainer was placed into a motorized miniature jeep which was further modified with appropriate safety and auxiliary control systems.

SUMMARY OF IMPACT

Many extremely young children with physical handicaps will eventually utilize a motorized wheelchair. For paraplegic individuals, a joystick control is commonly employed on powered wheelchairs. However, such a control is not well understood by small children. Although it is possible to train children in the actions of a joystick via computer games and motorized toys, the effect of self movement via joystick control cannot be adequately simulated by these means. An adapted motorized miniature vehicle would allow the disabled child to be seated inside and to operate the vehicle by joystick, in much the same fashion as a wheelchair controller. Thus, the disabled children would be adequately prepared to operate their own motorized wheelchairs once they can be properly fitted.

TECHNICAL DESCRIPTION

A Sears miniature jeep was modified to incorporate a joystick control instead of the foot pedal operated controls. The joystick was mounted to the side of the driver's seat and was connected to the pedal control wiring. The pedals were removed and the holes covered over. A special seat and seat belt was developed for infants and was placed into the driver's seat cavity. Padding was placed around the exterior of the jeep. The jeep and padding were colorfully decorated to motivate the users of the vehicle.

There were initially two speed controls for the vehicle. However, the fast control was disabled to avoid any high speed accidents and the speed control knob removed. The joystick control was spring loaded so that when the control was let go, it returned to a neutral position and the vehicle stopped via friction. The original brake was disabled to avoid sudden stops by the user.

A power override switch was placed in the exterior of the jeep with a remote switch connected via a jack and a 6 foot lead. Thus, a therapist could walk behind the jeep and could disable the power if an accident was imminent. The override switch was hidden behind a cover plate so that only a therapist could start the unit, not any small child.

The system was powered by a 6 volt battery which came standard with the original jeep. A Radio Shack joystick, external switch, and connectors were used in this project. The total cost of the jeep and all components including electronics, hardware, paint and decorations was $300.

A Hand Grip Training Device with Auditory Feedback to Serve as a Pre-Vocational Training System for the Profoundly Disabled

Designer: Steven Stoycos
Disabled Coordinator: Marcia Willson, Denton State School
Texas Department of Mental Health and Mental Retardation
Supervising Professors: Gerald Miller and William Hyman
Bioengineering Program
Texas A&M University
College Station, TX 77843-3120

INTRODUCTION

A motor skills and cause-effect feedback device was developed to enhance the skills of profoundly handicapped individuals and allow them to be phased into a sheltered workshop setting. The device consisted of a squeeze switch which operated a tape player. The switch was interfaced to a timing circuit so that a staff member could adjust the duration of squeezing required to initiate the feedback music.

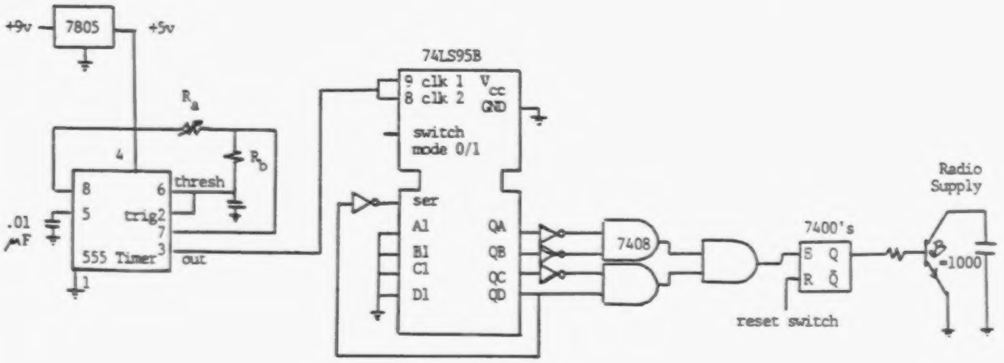
SUMMARY OF IMPACT

Many profoundly handicapped individuals who could be candidates for sheltered vocational workshops lack the motor skills to manipulate objects that will be encountered in a vocational setting. In addition, they may lack the attention span and motivation necessary to complete a desired task. A squeeze switch and music feedback system would alleviate both problems. The squeeze action would build hand strength and enforce a manipulating action that might be encountered later in a vocational workshop. The music feedback with variable timer would enforce the attention and motivation aspects of this task.

TECHNICAL DESCRIPTION

A spring loaded pair of pliers was utilized to provide squeezing action. Small contacts were placed on each end of the pliers and attached by hidden wire (within the plier frame interior) to the control circuit. When the pliers were closed, the circuit was also closed so that the following events occurred: a shift register initiates the timer circuit, which when complete (compared to a preset period) resets a flip-flop, which saturates a darlington transistor, which then closes the voltage supply circuit to power the tape player. The timer can vary the delay from 0-5 seconds. The action is momentary, so that the music plays only while the switch is closed.

The system consists of an 555 timer, 7495 shift register, 7805 voltage regulator, 7404 hex inverter, 7408 AND gate, 7400 NAND gate, darlington transistor, 100K trim pots, single pole-double throw switches, jacks, and 9 volt batteries. The unit is shown in the figure below with the accompanying circuit diagram.


+9v
7805
+5v
74LS95B
9 clk 1
8 clk 2
Vcc
GND
R_a
R_b
switch mode 0/1
4
8
6
thresh
5
trig2
7
3
.01 µF
555 Timer
out
1
ser
A1
B1
C1
D1
QA
QB
QC
QD
7408
7400's
S Q
R Q̄
reset switch
Radio Supply
B =1000

Prevocational Counting Trainer

Designers: Ed Thomas and George Tures
Client: Denton State School
Texas Department of Mental Health and Mental Retardation
Supervising Professors: William Hyman and Gerald Miller
Bioengineering Program
Texas A&M University
College Station, Texas 77843-3120

INTRODUCTION

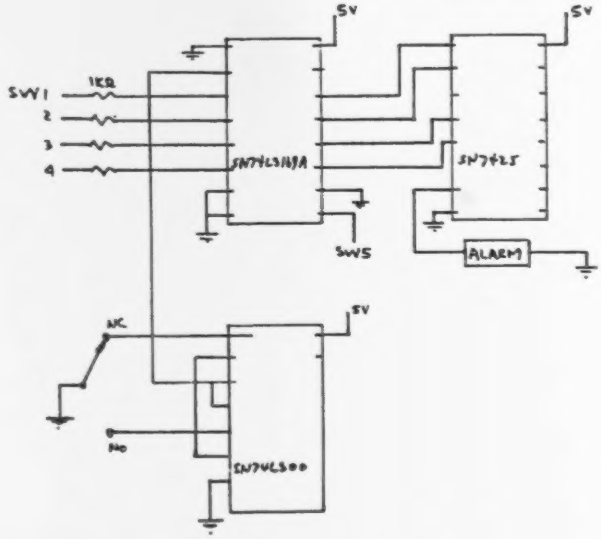
The prevocational counting trainer was designed for use in a program for resident clients of the Denton State School in which they are being prepared for subsequent work in the school's vocation sheltered workshop. Clients in the prevocational program have a variety of severe disabilites for which the training goals start with attentiveness to simple repetitive tasks. It is desirable in this setting for training tasks to resemble future work tasks, with the addition of visual or audible feedback to indicate task compliance or completion. In this case, the training goal is associated with counting of industrial type objects where a variable number of repeats would provide the desired feedback. In the system described here large metal balls are counted into a funnel. The trainer can preselect the number of balls required before the output buzzer sounds indicating successful completion of the task. The trainer can then reset the system. The goal is to initiate counting activity and to gradually increase the number of items that must be counted to trigger the system.

SUMMARY OF IMPACT

The sheltered workshop environment is used to either train clients for outside employment, or to provide a permanent place of employment for resident clients who are unable to progress to outside work. The work setting provides necessary daily activities, a feeling of accomplishmnet and self worth, and an income to the clients. At a facility like the Denton State School there are clients who are not ready for the workshop environment, but who could be educated toward the behavioral and skill requirements to function in the workshop. The device described here is currently in use in the prevocational training program toward reaching this goal.

TECHNICAL DESCRIPTION

The unit consists of a plexiglass cube with 12 inche sides. On the top of the cube is a circular opening which provides access to a funnel which is secured to the top from inside the box. The funnel accommodates the placement of 1 inch diameter balls which fall through the funnel into a container inside the box. The rear of the box is hinged to provide access to the collected balls and the switches which are used by the therapist to control the device. As each ball falls through the funnel it mechanicaly closes a switch which drives a counting circuit. When a preset number of counts is recorded a buzzer is energized. The therapist can then reset the counter using a switch, and then rearm the counter at which time the task can be repeated. The therapist can also select the number of balls (1 to 12) which must pass through the system before the buzzer is sounded. A binary switch logic circuit is used to set this number. The details of the circuit are contained in the accompaning figures.



CIRCUIT DIAGRAM

Devices to Enhance Productivity for Disabled Workers in Sheltered Vocational Workshops

Designers: George Tures, Winston Marshall, Ed Thomas,
William Pierce, Steven Stoycos, Mark Benden
Disabled Coordinator: Marcia Willson, Denton State School
Texas Department of Mental Health and Mental Retardation
Supervising Professors: Gerald Miller and William Hyman
Bioengineering Program
Texas A&M University
College Station, TX 77843-3120

INTRODUCTION

A variety of devices were developed to increase the productivity of cognitively and physically disabled clients in a sheltered vocational workshop. These clients suffered from visual impairments, muscular and motor impairments, and limited cognition. Various tasks were supported which were created from contractual arrangements between the state school and area industries.

SUMMARY OF IMPACT

Individuals with visual disabilities or motor dysfunction lack the hand coordination and strength or the hand-eye coordination to quickly assemble items which are contracted with a vocational workshop. As a result, productivity is stalled in such a setting since the construction tools, jigs and systems are ill suited for handicapped individuals. A series of assistive devices was created to increase the disabled workers productivity by designing the system to meet the specific disabilities of the users.

TECHNICAL DESCRIPTION

Several different systems were developed to assist various tasks in the sheltered vocational workshop. These include a jig and collection system for a tablecloth holder task, a jig and collection system for a film unwinding task, a system to hold and organize a tie hanger assembly task, and a jig to assist in the assembly of tie racks. These will each be described separately below.

Tablecloth Holder Assembly System

Clients were given the task of assembling plastic tablecloth holders by attaching velcro strips to the ends of each plastic piece. Twelve of these were to be built and placed in small bags for later marketing. However, the clients were unable to manipulate the plastic pieces, were unable to properly apply the adhesive velcro strip, and were unable to accurately determine how many of these items had been built for insertion into a bag. A jig was created to alleviate all of these problems. The jig consisted of a plexiglass frame with twelve slots on a tilted plane hinged to the frame. The slots were of the proper size to insert the velcro pad and a plastic tablecloth holder. Once all 12 slots had been filled, the assembly was tilted down to allow the completed holders to slide into an assembly bag. This unit is shown in figure 1 below.

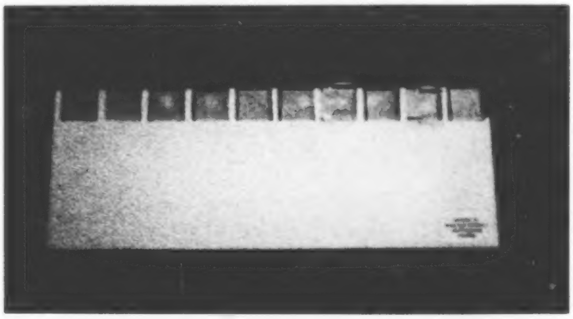


Figure 1 TABLECLOTH HOLDER ASSEMBLY

Film Removal System

A task to remove photographic film from reels utilized physically and visually impaired individuals. The clients would manually unwind film from a reel, discard the film, and place the reels in a storage box to be returned to the contracting agency. Many of the clients had the use of only one hand and could not easily manipulate the reels to unwind them. A jig was created to allow one handed unwinding of multiple reels. The jig consisted of a horizontal post which held up to 6 reels. The film leaders were placed into a roller crank assembly. The rollers were rubberized to hold the film. A slot was located beyond the roller assembly so that the unrolled film could drop into a waste box located below the jig. Once the film had been unwound, the reel holder post could be rotated out from the support post and the empty reels slid off into a storage box. The components to this system consisted of 2" by 6" wood framing posts, aluminum stock, rubber tubing, a metal handle, and wooden dowels. The unit is shown in figure 2 below.

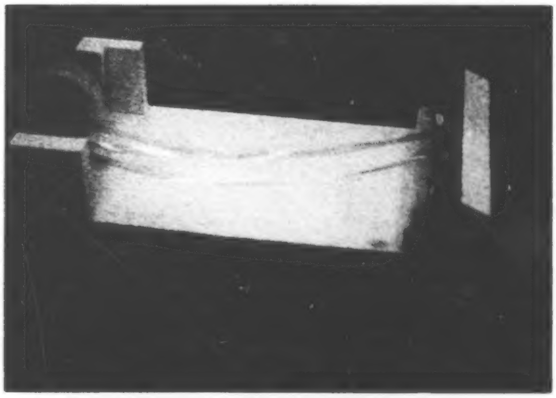


Figure 2 FILM REMOVAL

Tie Hanger Assembly System

Cognitively and physically disabled individuals were to take 12 plastic necktie holders from a large supply box and place them into an individualized bag for later stapling, labeling and marketing. However, these individuals could not count to 12 and thus, could not place the proper number of items into the small bags. A counting and assembly system was created to assist in this task. The unit consisted of a metal post which could swing into place within a series of 12 wooden slots on a wooden frame. The client would take a new holder and place it on the post within one of the slots. Once all of the slots were full, the post could swivel out so that all of the hangers could be slid off the post into a small bag placed at the end of the post. The components of this unit consisted of 2" by 4" wooden frames, a 1/4" unthreaded aluminum rod, plywood, hinges, and associated hardware. This unit is shown in figure 3.

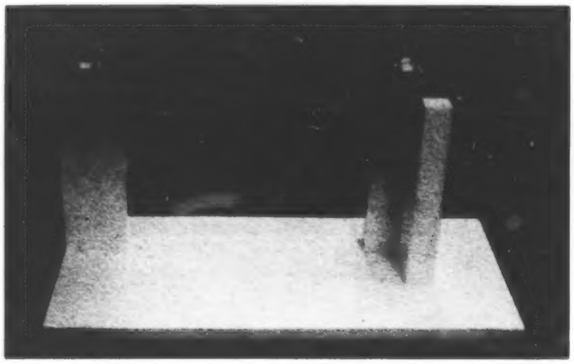


Figure 3 TIE HOLDER ASSEMBLY

Tie Rack Assembly System

A contract to build tie racks was developed by the vocational workshop. These racks consisted of a wooden frame with swiveling metal posts which held neckties. The assembly of these racks was quite involved since each metal post required insertion into a two part wood and metal frame. A jig was used to hold the frame and allow alignment and insertion of the metal posts in a two part process. However, since the workers who used this jig were visually impaired, they could not see the holes in the frame well enough to insert the posts. An add-on jig was developed to assist insertion of the posts into the frame. This new jig attached to the original jig and served as a guide for insertion of the posts. It consisted of a series of countersunk holes which would align with the proper slots in the frame to allow insertion of the posts. The new jig was made of brass and was built in pairs which were screwed onto both sides of the original jig (figure 4). The users now can feel for the next countersunk hole and ease a post into it.

Figure 4 TIE RACK ASSEMBLY

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CHAPTER 9

TEXAS TECH UNIVERSITY
SENIOR PROJECTS DEVELOPMENT GROUP
COLLEGE OF EDUCATION AND COLLEGE OF ENGINEERING
LUBBOCK, TEXAS 79409

Principal Investigators:

Richard A. Dudek (806) 742-3543

Oliver D. Hensley (806) 742-2388

Jesse C. Jones (806) 742-3563

Tom Leamon (806) 742-3543

Donna Irons Reavis (806) 742-1958

"Developing an Eye Tracking Device (ETD) for Individuals with Handicaps"
An ETD Linked to a Computer Generated Communication System for Students with Multiple Handicaps

Designers: Bobby Hudgens, Greg Hatfield, Reese Wright; First Team
Ka Lam William Chio and Chow Ming Wong; Second Team
Coordinator for the Disabled Students: Don Foreman
Supervising Professors: Dr. Michael Parten and Mr. Eddie Arrant
Department of Electrical Engineering
Dr. Oliver D. Hensley and Dr. Donna Reavis
College of Education
Texas Tech University
Lubbock, Texas 79409

INTRODUCTION

The purpose of designing an Eye-Tracking Device (ETD) was to develop a communication device for Terry, a 19-year-old teenager who has profound scoliosis and severe spasticity. Terry has never been able to communicate with those around him. Don Foreman, Terry's teacher, was convinced that although Terry had an uncontrollable body, he had a bright mind and a wonderful sense of humor. The difficulty was that the messages from the brain became garbled and uncontrolled before they could be uttered. Don was the only one who believed he was in touch with Terry's mind. He could communicate very crudely by a simple system of Terry's winking and Don's saying options until they hit on what Terry thought. The problem for the Senior Design Team was to find a way of getting Terry's imprisoned thoughts out to others--something that had not been accomplished in 19 years of internment in a state school. After two years of concentrated interdisciplinary research, the Senior Projects Team did free Terry's thoughts.

SUMMARY OF IMPACT

The ETD was a critical technological component in the Synthetic Speech Communications System built for Terry. The technology created by the Senior Projects Team opens up a whole new area of basic research related to communicating with the severely and profoundly disabled child.

This article will mention only a few of many ancillary benefits resulting from the Senior Projects Team's investigation. First, there is the improvement in Terry from the Hawthorne effect. People outside the school paid attention to him, asked his opinion. That improved his mental outlook.

A small amount of seed money from the NSF Senior Projects started this long-term project and convinced the Texas Rehabilitation Commission, the Ballenger School, and Texas Tech University to pool their financial and human resources to develop a system to be used specifically by Terry to benefit his life. This communication device allowed Terry to communicate with the outside world--to express his needs, to show his feelings, and to learn.

TECHNICAL DESCRIPTION

The corneal reflection method of eye-tracking uses the subject's cornea to reflect light from a stationary light source. The light source will cause a bright spot to appear on the cornea, and the bright spot will stay at the same position when the subject moves his eyes; thus, relatively speaking, the bright spot moves whereas the eyes do not. This is an important characteristic in determining the eye focus. One advantage of the corneal reflection method is that the bright spot shown on the pupil will remain in the same position on the cornea even though the head moves (Young & Sheena, p. 414). This is the main reason for Research Group #1 deciding to use the corneal reflection method to track the eye movement.

Bobby Hudgens determined that VOCAID with certain modifications was the voice synthesizer suitable for Terry. It can pronounce phrases such as "I WOULD LIKE TO USE THE BATHROOM" or "I AM IN PAIN". It can also pronounce the alphabet and the numbers. Although the vocabulary for VOCAID is limited, it is extremely useful for severely handicapped people.

Figure 1--Block Diagram of the Project represents the major components in the project. The video camera and its powerful zoom lens are responsible for obtaining the analog video signal from the eye. Then the PC-EYE digitizes the picture so that the computer can store PC-EYE digital data in its memory buffer. After data storage, the computer presents a menu which allows Terry to select by eye gaze the Vocaid graphics desired, and the computer will analyze the PC-EYE picture to find the gaze-point. After the gaze point is determined, the computer sends out proper data to the interface circuit which serves as a bridge between the computer and the Vocaid, so that the desired button of the Vocaid voice synthesizer can be activated, thus allowing Terry to talk.

The Synthetic Speech Communications System cost in excess of $2,000 for materials and supplies. The equipment costs were shared among the NSF, Texas Tech University, and Texas Rehabilitation Commission.

More than 400 student hours were spent in designing, fabricating and testing the system. Now that we understand the parameters of the System, it can be modified for other severely and profoundly handicapped children.

Preliminary data from Terry's case study indicate that these children are more intelligent than professional assessments indicate. Texas Tech University intends to investigate the learning abilities of similar children.

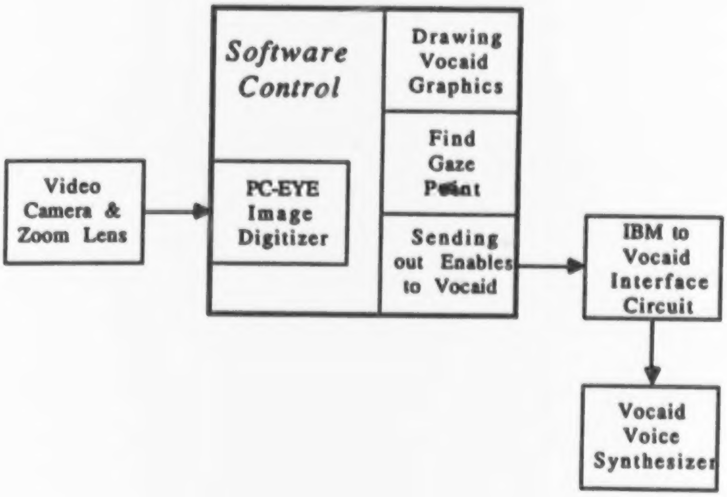


Fig. 1 Block Diagram of the Project

"Developing a Prototype of a Multiposition-Low-Base Wheelchair for the Classroom"

An Innovative Wheelchair for Children with Severe Cerebral Palsy

Designer: Ross McDonald
Teacher of the Disabled: Ms. Lynn Vitatoe
Supervising Professors: Mr. Jesse Jones
Department of Mechanical Engineering
Dr. Oliver D. Hensley and Dr. Donna Reavis
College of Education
Texas Tech University
Lubbock, Texas 79409

INTRODUCTION

A Multiposition-Low-Base Wheelchair for the classroom was designed and constructed for a child in the first grade of a regular public school. Jay, the recipient of this customized wheelchair, is a very intelligent and socially well-adjusted six-year-old with severe cerebral palsy with spastic quadriplegia. The disease and confinement to a conventional wheelchair have greatly retarded the movement and endurance of a youngster who is capable of competing and excelling scholastically with his classmates. Unfortunately, his spastic movements leave him without control of the lower hip area. His teacher and parents asked for a wheelchair that would allow Jay to sit at first grade tables, change his position as the furniture demanded and allow Jay to control the chair movement. Jay's teacher thought that the multipositioned chair would alleviate the physical fatigue experienced by Jay after two hours in a conventional wheelchair.

SUMMARY OF IMPACT

Jay thrived on being part of an experimental project. He discussed the design and enjoyed working with Ross and Ms. Vitatoe on the testing of the Multiposition-Low-Base Wheelchair.

Unfortunately, all project devices do not work forever. The Multiposition-Low-Base Wheelchair is a case in point. The adjustable height screw failed after a short service, leaving the chair functions below expectations. This is a problem for the University because Senior Projects students graduate and leave Lubbock and our departments do not make follow-up repair calls. The parents and Jay are gracious and will wait for another phase of Senior Projects students who might want to improve on the design. The PI's have proposed that public school maintenance workers repair and maintain assistive devices or that the parents do the repairs. Unfortunately, when we design and fabricate it and give it away, we still seem to own it when it needs service.

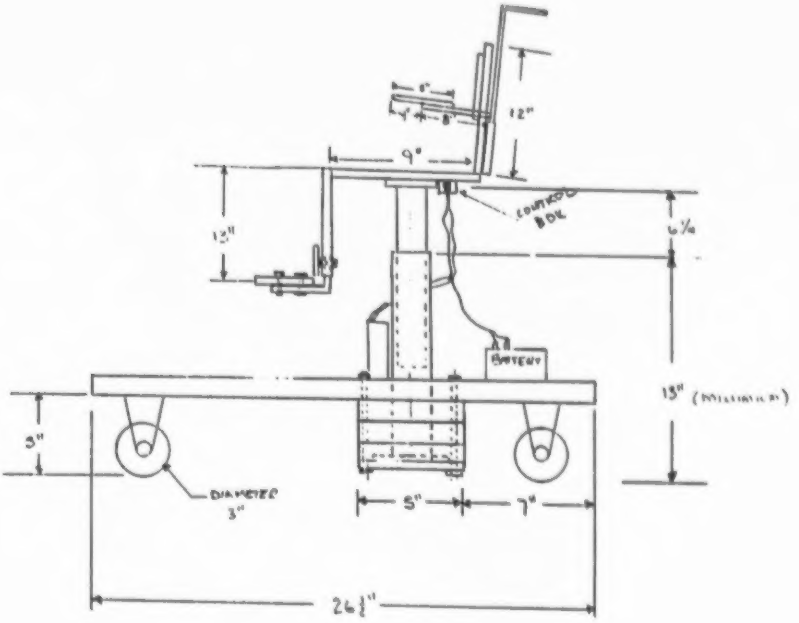
TECHNICAL DESCRIPTION

Mr. McDonald tried two design concepts which proved to be inappropriate. The third and final design concept which was adopted was a lift mechanism that is available on the market. Because the device was already constructed, time was saved by purchasing the lift mechanism rather than constructing one. The lift mechanism consists of a lead screw attached to a reversible DC motor which is geared down to enable the wheelchair seat to be raised up and down at a velocity of approximately 0.75 inches per second. The device is compact and can be operated by the wheelchair user. The lift mechanism allows a height differential of 6.25 inches for the chair. Additionally, because the lead screw is enclosed in a sleeve, the device is deemed to be quite safe.

After selection of the lift mechanism, the next step was the design of a complete apparatus compatible with the lift mechanism. The final design is shown in Figures 3 and 4 for side and front views, respectively. A design criterion for the construction of the wheelchair was that the device be able to grow with the child. To satisfy this requirement, the foot rests as well as initial height of the seat are adjustable to compensate for the child's growing body. An additional design constraint was that the wheelchair arms be removable to enable the wheelchair to be placed under a narrow or otherwise constricting desk. This goal was achieved.

The wheelchair is compact and designed to be pushed from the rear. The lift mechanism is controlled by the child so as to give him some autonomy. Thus, the child can adjust the seat height of the chair to his own satisfaction. The lift mechanism is powered by a compact rechargeable DC battery that fits under the seat of the apparatus. A bottom-heavy design was constructed to lessen the chance that the device could inadvertently tip over. This bottom-heavy design was constructed by using angle iron (1-inch flange) for the base frame.

The Multiposition-Low-Base Wheelchair development costs were $375 and 87 hours of student time.



DESIGN CONCEPT CONSTRUCTED (SIDE VIEW)

"Automated Packaging Process"
The Development of an Automated Egg Sorting Machine for Mentally and Physically Disabled Students

Designers: Donna DiMarco, Boris Dmitrijev, Melvyn Fernandez
and David West
Coordinator for the Disabled Students: Mr. Jack Kirkpatrick
Supervising Professors: Mr. J. C. Jones and Dr. Oliver Hensley
Department of Mechanical Engineering and College of Education
Texas Tech University
Lubbock, Texas 79409

INTRODUCTION

This Senior Project addresses the difficult problem of designing, fabricating, and testing an automated egg sorting machine that could be operated by physically and mentally handicapped students. Commercially available equipment was not suitable as conventional machines are too hazardous to have in a sheltered workshop and they do not have the adaptive technology needed by handicapped persons. Consequently, the Senior Projects Team designed a system that incorporated every conceivable safety device and included innovative devices for performing the work while assuring maximum safety and access by handicapped students.

The Lubbock State School is a school for the mentally and physically handicapped. Some of these students earn a small income by stuffing miniature toys in plastic eggs. There are nine different toys which are stuffed into the eggs after which the eggs are stockpiled and subsequently packaged for delivery. These students can stuff approximately 200,000 eggs per week. The Lubbock State School had a production problem with the packaging of the toy eggs. The eggs are hand sorted and packed into boxes containing 250 eggs. Each of these boxes required a different mixture of toys according to individual contracts. This required individual sorting of the eggs for packaging. Only 80,000 eggs could be packaged per week. A huge backlog of stuffed but unpackaged eggs existed. This bottleneck prevented the school from placing more students in the workshop.

SUMMARY OF IMPACT

This project helped the Lubbock State School automate the packaging process. Bins to hold the eggs were designed and fabricated. An Apple II computer was used to control the output of eggs from each bin with the use of a computer interface system. By automating the packaging process with a computer interface system, the students at the State School became involved with the process. The Automated Egg Processing System eliminated the very large backlog of unpackaged eggs and permitted the School Coordinator to use more students. The Automated Egg Processing System worked beyond the expectations of the Coordinator of the workshop.

TECHNICAL DESCRIPTION

The Automated Egg Sorting System consists of storage bins, rotary disks, funnels and gravity chutes. The storage bins are capable of holding approximately 1500 eggs each. The 8-slot rotary disks turning at 6 RPM are able to deliver approximately 48 eggs per minute per bin. The funnel design ensures the delivery of only one egg at a time. The gravity chutes deliver the eggs from the bins to a central location without clogging.

The electrical system consists of a computer, related software, associated circuitry, photocells and electric motors. The computer used is a previously owned, inexpensive Apple II. The software is a program written in BASIC language. The associated circuitry includes transistors, 2 multiplexers and 2 demultiplexers connected to a 5- and 12-volt power supply. The photocells used are prefabricated 12-volt optical eyes. The motors are 110-volt, 6-RPM Dayton Electric Motors.

After fabrication and assembly of the above components, the system was evaluated for use in a sheltered workshop environment. Custom-designed adaptive devices for specific handicapped persons were designed, installed, and tested for use by particular persons. Test runs indicated that the packaging capability of the system was approximately 30 boxes of eggs per hour. When calculated on a weekly basis, 300,000 eggs per week can be packaged. The automated packaging process thus represents a 250 percent increase in productivity over the previous manual process.

At present, the Lubbock State School is packaging nine different toys, thus nine storage bins were required. Each 2x2x3 foot bin was constructed of #28 gage sheet metal (see Figure 1). The 12 cubic foot volume allows each bin to hold approximately 1500 eggs. The eggs are delivered to a rotary disk feeder by an off-centered funnel (see Figure 2). The funnel is off-centered to allow only one egg to drop from the bin at a time. The feeder consists of an 18-inch diameter disk driven by an electric motor. Each disk has eight 2.5-inch diameter slots machined in its face. These slots are centered on a 15.5-inch diameter circle. An egg drops into the slot and is rotated around until it becomes aligned with a delivery chute. The delivery chute system consists of folded #28 gage sheet metal. The chute system is an open trough. It is welded to the support structure of the bins. The chute converges to a convenient central location where the boxes are filled with eggs. The support structure of the bins is made of angle iron.

The final cost of the operational system was approximately $2,500 and over 384 hours of Senior Projects students' time and an additional 300 man hours from technicians and machinists employed by the Lubbock State School and the Biocybernetics Laboratory of Texas Tech University.

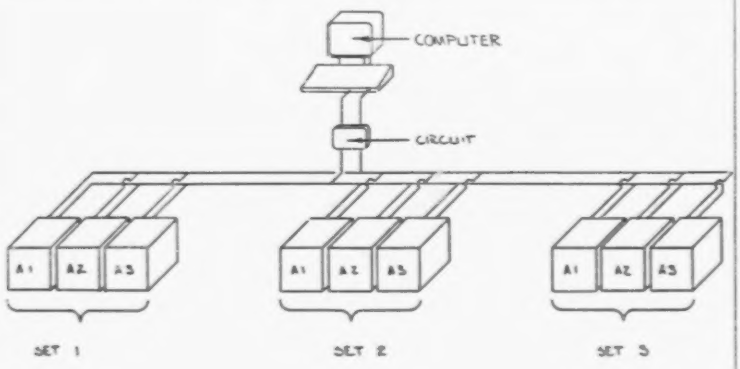


FIG 5 BIN CONTROL LAYOUT

"Automated Gravel Bagging System"
Creating a Sheltered Workshop Laboratory that Provides Experience and Adaptive Equipment Needed by Handicapped Students

Designers: John Julian, Victor Deutsch, John Diederich
Coordinator for the Disabled Students: Mr. Jack Kirkpatrick
Supervising Professors: Mr. Jesse Jones and Dr. Atila Ertas
Department of Mechanical Engineering
Texas Tech University
Lubbock, Texas 79409-1021

INTRODUCTION

The purpose of the Automated Gravel Bagging System (AGBS) was to design and construct a sheltered-workshop laboratory that could be controlled by handicapped clients at the Lubbock State School.

Several of the bagging system's components were commercially available such as the vertical elevator, the sewing mechanism, the sump pump, and the linear actuator. Other components such as the weigher and gate mechanism were designed and fabricated by the project team. All components were either modified or designed to accommodate the particular client's disabilities.

Primary control of the system is achieved through the use of a computer terminal operated by a physically handicapped client. Mentally handicapped clients operate the system's on-line functions. Several customized adaptive devices were designed that enabled persons with particular disabilities to work in the system.

SUMMARY OF IMPACT

The Automated Gravel Bagging System presents many benefits to the clients. The handicapped students run the system from start to finish. Two primary benefits occur. The disabled student gains satisfaction, pride, and money every time he is successful in bagging a load of gravel. Success breeds success; therefore, the handicapped students are learning that they can perform most jobs if they will work with designers in modifying equipment that will interface with standard systems. The effects of this work success reach into the students' home life as well. The sheltered-workshop laboratory provides the first step toward work in the real world.

The students have learned valuable skills and they demonstrate they can make a valuable contribution to the production industry which is external to the Lubbock State School. Students can go out into the world, take a job at an assembly plant, and make $3.50 to $5.00 an hour. This is the goal of many of the clients at the State School.

Without the cooperation of the Senior Projects staff, the Texas Rehabilitation Commission, Lubbock State School staff, and the dedicated work of the Project Team, this laboratory and AGBS would not have been designed, built and tested.

The laboratory and system are in use every workday with students eagerly awaiting their turn to run the system.

TECHNICAL DESCRIPTION

The Automated Gravel Bagging System starts by using a vertical elevator to lift the gravel from a gravel bin located below ground to the hopper. The system then employs a gravel weigher mechanism to ensure that a uniform volume of gravel is delivered to the bags. Once the bags are filled, they are closed with a sewing mechanism and transported to a loading area by a non-driven conveyor. Computer control was incorporated into the system to supply the severely physically handicapped with a means of controlling various aspects of the operation. These control operations are simple but challenging, and they present no danger to the students from the moving machinery. The client's safety was of the utmost importance in the design of this system.

Gravel Pit

Gravel that is transported to the school will be dumped directly into a gravel pit. The pit's walls are designed to withstand the forces exerted by seven yards of gravel. Sloping the bottom of the pit at a 45-degree angle keeps the gravel flowing steadily toward the pit's lower door. This angle exceeds the concrete surfaces angle of repose, 37.5, which was found through experimentation.

Gate Mechanism

The main purpose of the gate mechanism is to regulate the flow of gravel to the vertical elevator. The gate consists of a vertical door and vertical running tracks. The running track is constructed of 1018 Hot Rolled steel. The bearings used in the running tracks are 0.75-inch O.D. with a 0.25-inch I.D. The bearings provide a smooth and easy vertical movement for the sliding door. The sliding door is constructed of 0.3125-inch-thick, 1010 Hot Rolled steel. The door is powered by a linear actuator that can raise the door up to 12 inches.

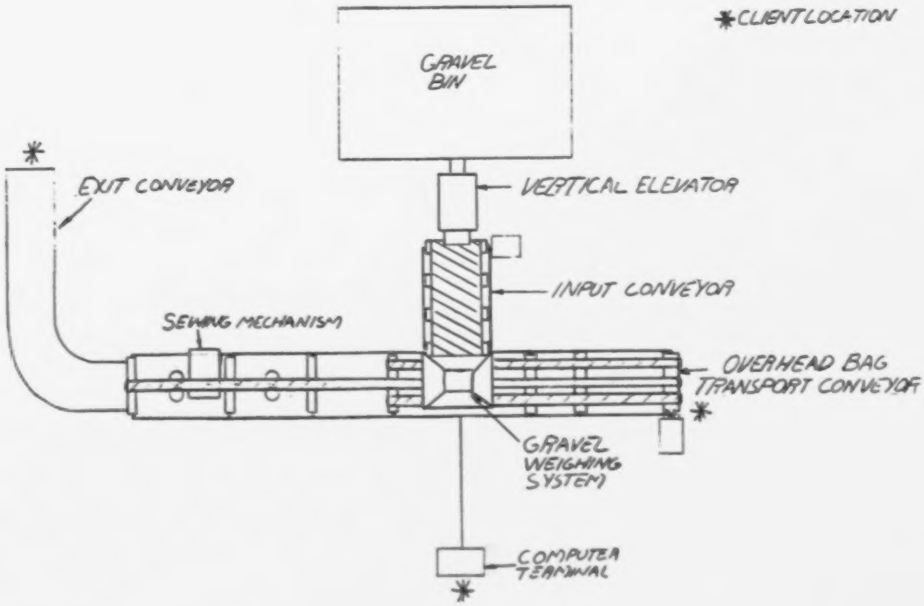
Linear Actuator

The force required to open and close the door is supplied by a Dayton linear actuator. The maximum extended distance and applied load is 12 inches and 300 pounds. This AC model comes with fully adjustable limit switches, which can be set to stop the motion of the lifting screw at any desired point of travel in either direction. This characteristic gives the system the required variable gravel flow and fast gravel flow shut-off.

Vertical Bucket Elevator

Transferring the gravel from the gravel pit to the surge bin is accomplished by using a vertical bucket elevator. The elevator's 220 CFM capacity more than meets the production requirement of 300 bags a day.

A symbol of success for most projects is completion on time and under budget. With a great deal of pride, the members of the gravel bagging project proclaim that their project accomplished both. The expenses incurred through completion of this project were less than the $5,000 estimated for the project which were mostly paid for by the Lubbock State School. Less than $500 was from the Senior Projects Fund.



GRAVEL BAGGING SYSTEM (TOP VIEW)

CHEST CONTROLLED SEWING MACHINES

Designer - Zane D. Curry[1]
Supervisor - Tom B. Leamon[2], Ph.D.
Merchandising, Environmental Design and Consumer Economics[1]
Industrial Engineering[2]
Texas Tech University
Lubbock, TX 79409

Introduction

Commercially available machines used in the stitching trade such as sewing machines, serging machines, etc. are normally controlled by a treadle operation, which changes sewing speed by acting through a series of mechanical linkages to the clutch on the sewing machine motor. In addition, the presser-foot (the device which locates the fabric in relationship to the needle or cutters) is normally foot operated. In practical terms, such machinery is not accessible to the wheelchair disabled and cannot be controlled by those who do not have use of their lower limbs. A student enrolled in the College of Home Economics, who intends majoring in fashion design is confined to a wheel chair due to a spinal cord injury. Functionally, she has no control of her lower limbs. The program in which she is enrolled has upwards of 18 hours of course work which require the use of sewing and allied machines which are operated with a treadle and with foot operation of the machine presser-foot. Without a design solution it would have been impossible for her to graduate from her chosen program.

Impact Summary

The occupations associated with sewing machines appear, on the one hand, to be highly compatible with the lack of mobility of paraplegics, in that they normally involve a fixed work station and can be operated from a sitting position. Such opportunities for wheelchair paraplegics are entirely vitiated by their need to gain manual access to the stitching area and by the need to use foot controls. It appears that both in the individual case under investigation and in a much wider sample of the disabled population, a solution to this problem would provide wide employment opportunities. Thus, a requirement for extendibility or generalizability of possible solutions was added to this design project. Namely, a solution was sought which could be reproduced on a variety of machines associated with stitching operations.

Technical Description

A detailed task analysis was performed, based on direct observation and analysis of video tapes of non-handicapped and the handicapped subject attempting to perform the operations.

The clear need to relocate the control location suggested electromechanical devices. However, the need for rapidly changing and highly consistent forces for use over extended periods, indicated that such solutions were likely to be expensive and had the potential for being unreliable. Consequently, the mechanical linkages that link treadle and the clutch on the drive motor were carefully examined and a solution based upon additional mechanical linkages was designed and a prototype built.

The stitching operation largely precludes the use of any hand controller, for precise positioning of the work piece in relationship to the needle or serging blade is an absolute requirement of the task. Consequently, alternative effector mechanisms were examined. Elbow and shoulder positions will produce adverse interactions with the precise control requirements of the hands, and an experimental configuration was developed, using a chest plate operating approximately in the region of the sternum. The potential for causing musculoskeletal stresses by the use of postural muscles to control this mechanism was considered, together with potentially low level of precision available from the operation of the control by these muscles.

In preliminary trials, however, the subject did not experience undo postural stress and very rapidly appeared to be able to obtain the fine positional control required. Several trials supported the suitability of this design solution.

A further question was raised; what is the comparison of the performance of the disabled with that of non-disabled operators. That is, would the design constrain the disabled subject into an inherently inferior performance pattern or could she be expected to reach full performance standards. An experiment was developed, and is currently being carried out, which compares the performance of able bodied subjects, both on traditional treadle control and on the chest control. Preliminary results showed that the chest control produces results at least equal to the treadle and there is evidence to suggest that the former is a preferred control, even for the able bodied subjects. The performance measures utilized, involved both the accuracy of line following and the time to complete the operations.

Subject to further experimentation and confirmation of these pilot studies, it appears that the device enables the disabled to operate any one of a series of machines by providing both access to and control of the machine. It appears to provide the potential for achieving equal performance with the able bodied using conventional controls.

"The Development of Assistive Devices for Deformed Hands"
Designing Devices that Allow Handicapped Children to Independently Operate Classroom Equipment

Designers: Ames Hwang, Valerie Matthews, and David Crowe
Coordinator for the Disabled: Mr. Jack Kirkpatrick
Supervising Professor: Dr. W. B. Jones
Department of Mechanical Engineering
Texas Tech University
Lubbock, Texas 79409

INTRODUCTION

The manipulation of common machine tools and classroom furniture is very important in the Senior Projects' strategy for assisting handicapped students to integrate themselves into the mainstream of school and life. Some children have such severe deformities of the hands that they cannot function in an ordinary classroom. However, if they are given adaptive devices molded to their hand configurations, they can perform most operations in an ordinary class or in our Sheltered-Workshop Laboratories.

This Senior Project produced two prototype devices for use as assistive devices for deformed hands. The first device, a pair of modified pliers, increases a handicapped student's strength by about four times. The new head design is used to grip different shaped objects. It can turn knobs, pick up small objects, and open push-button seat belts. The handles are custom designed to fit the shape of the hand, easing the stress on the fingers of the handicapped student. The second device is a strap wrench primarily designed to open jars or door knobs. A continuous belt is attached to the one-piece handle. The belt is adjustable to various sizes of jars. The handle is also formed to fit the user's hand. Small forces are needed to operate the tools and the stresses incurred are relatively low. Both designs are simple and suitable for injection molding.

SUMMARY OF IMPACT

For a Senior Projects program to function efficiently requires a great deal of coordination among the handicapped students, the coordinators of the disabled, university professors and students who do most of the design, fabrication, and testing of various orthotic and assistive devices. All of our Senior Projects devices have grown out of needs of handicapped individuals. Many of the devices can be constructed only on a research university campus, such as Texas Tech University, where there is elegant education, sophisticated science and advanced technology.

The modification of Channellock Pliers and the development of a strap wrench ostensibly may seem a trivial and low-priority engineering and education problem. Not much basic research here. But, there is a great deal of production research that has significance for production of custom-designed tools for the handicapped. Most importantly, for our handicapped students to function in the Sheltered-Workshop Laboratories and in cooperative employment, they must have adaptive devices that they can use. These devices are used by handicapped students in school and later in cooperative employment.

TECHNICAL DESCRIPTION

The objective of this Senior Project was to modify two basic hand tools that can be used easily and effectively by handicapped school children to perform a variety of tasks. The two tools that have been selected are slip-joint pliers and a strap wrench. These tools will aid in the motions of pinching or grasping and twisting. The design of the tools will increase the strength of the child.

Torque and Leverage

A handicapped child can also increase his or her strength through leverage. The force required to hold an object (F1) can be achieved by applying a smaller force (F2) at a distance and creating opposing torques. The necessary force is decreased by a factor of x1/x2.

Results: Tool 1 - Pliers

The first tool is a modified pair of nine and one-half inch Channellock pliers. The purpose of this tool is to aid a handicapped child in grasping and/or turning small objects such as television or radio knobs. Another main function of the pliers is to help in unfastening the push-button type of seat belts.

This problem was approached first by studying a pair of commercially available Channellock pliers. A silicon rubber mold was made of the steel pliers, then an epoxy model was cast from the mold. Results of photoelastic analysis revealed that the greatest stress occurred at the narrow section of the upper handle when no torque was applied. This stress was nearly twice as great as the stress in the narrow section of the lower handle. Stress concentrations also occurred at the corners of the head of the pliers. However, the stress lines were uniform along the handles indicating no stress concentrations. A downward torque applied to the pliers showed increasing stresses in the upper handle. Conversely, an upward torque increased the stresses in the lower handle.

Tool 2 - Strap Wrench

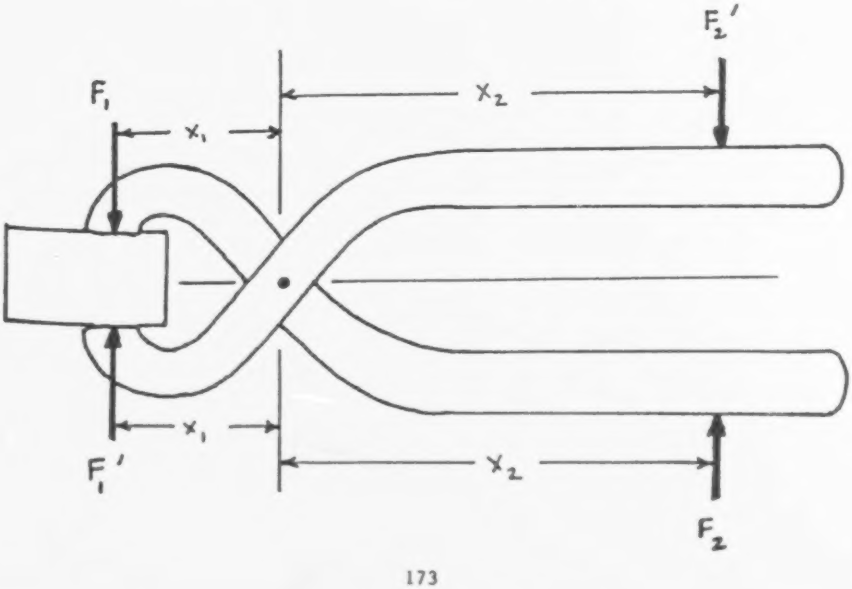
The second assistive tool is a strap wrench. The purpose of this tool is to help a child open jars, knobs, or anything that requires twisting. Unlike the modified pliers, the strap wrench is built entirely from scratch using new designs.

The frame was machined out of five-eighths-inch sheet aluminum. Two curves were cut into the head to accommodate both small and large diameters. An 18-inch, toothed polyurethane sewing machine belt was attached to the other end of the head. A notch was cut out of the aluminum near the end of the handle for the belt to go through for adjustment. A top plate was attached to the head of the tool to aid in placement and use of the tool. The handle of the strap wrench was dipped into the melted thermoplastic and shaped to the hand. The tool was designed to be pushed away from the body. The near side of the handle was cup-shaped to fit the eccentricities of the palm of the hand.

Texas Tech University's costs for tooling and production equipment were considerable. But, the actual allowable costs to this project were less than $200 and 56 hours of Senior Projects students' time.

$$F_1 x_1 = F_2 x_2 \qquad F_1' x_1 = F_2' x_2$$

$$F_2 = {}^{x_1}\!/_{x_2} F_1 \qquad F_2' = {}^{x_1}\!/_{x_2} F_1'$$



"Development of a Therapeutic Crawler"
The Design and Fabrication of a Therapeutic Crawler for Students with Multiple Handicaps

Designers: Jim Bielstein, Mike Etheridge, Lance Free,
Nat Phillips, Anita Green and Alan Tribble
Supervising Professors: Mr. Jesse C. Jones
Department of Mechanical Engineering
Dr. Oliver D. Hensley and Dr. Donna Reavis
College of Education
Texas Tech University
Lubbock, Texas 79409

INTRODUCTION

Pam is a physically and mentally handicapped twelve-year-old child. She is blind and non-ambulatory which restricts her to a wheelchair or bed. Pam's physical limitations are due to her slightly curved spine, one leg being shorter than the other, and below average motor skills. She exhibits poor posture and balance. She is unable to bear much weight on her arms or legs. Pam has little active movement and cannot independently attain positions; however, she does respond to physical therapy. She has normal muscular tone and adequate head and trunk control when sitting in a wheelchair. As a result of her present therapy, she can now stay in a four-point position (on hands and knees) for a short period of time.

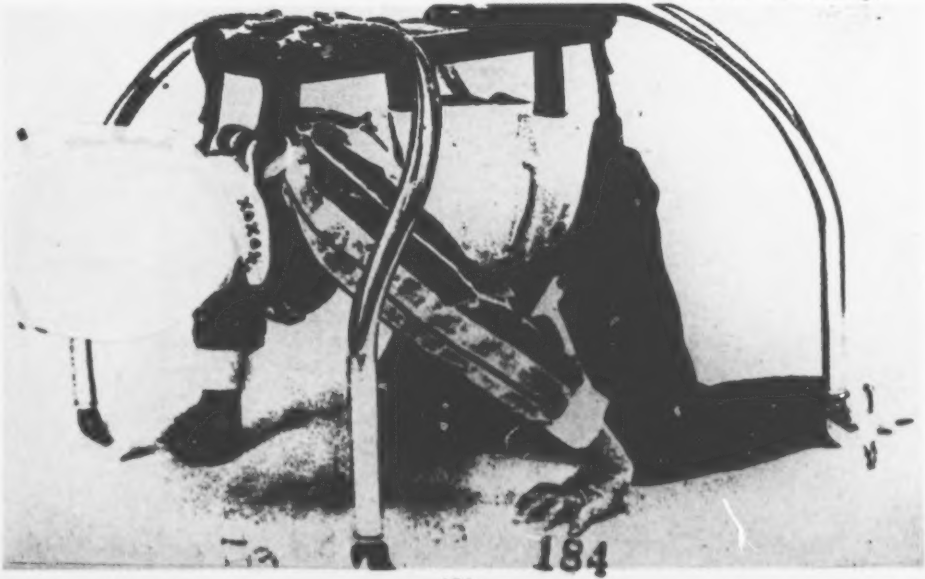
The physical goals for Pam are maintenance of a four-point position for an extended period of time and an increase in overall strength and balance. Her long-range physical goal is to increase her mobility. Also incorporated into her short- and long-range goals is the development of independence in self-help skills.

A crawler that was previously used in therapy was not adjustable, and in some ways movement was rough and slow. The new crawler is adjustable and can be adapted to improve the exercise of specific limbs.

SUMMARY OF IMPACT

The crawler was designed and fabricated to specifications as required by the therapist for Pam, the handicapped client for this project. This therapeutic aid device will give Pam a sense of independence and mobility, providing another way to explore her environment. Pam and other children with similar handicaps will use the crawler for improving their self confidence and exploring their environment.

By combining the support structure and leg assembly, harness assembly, and wheel assembly, a more adaptable and maneuverable crawler has been designed. This design significantly expands the client's rate of progress by adding to the tools of the therapist. The crawler, in the early stages of the client's therapy, aids in supporting her body in a four-point position while, afterwards, helping to develop balance and muscle control needed to begin independent crawling.



TECHNICAL DESCRIPTION

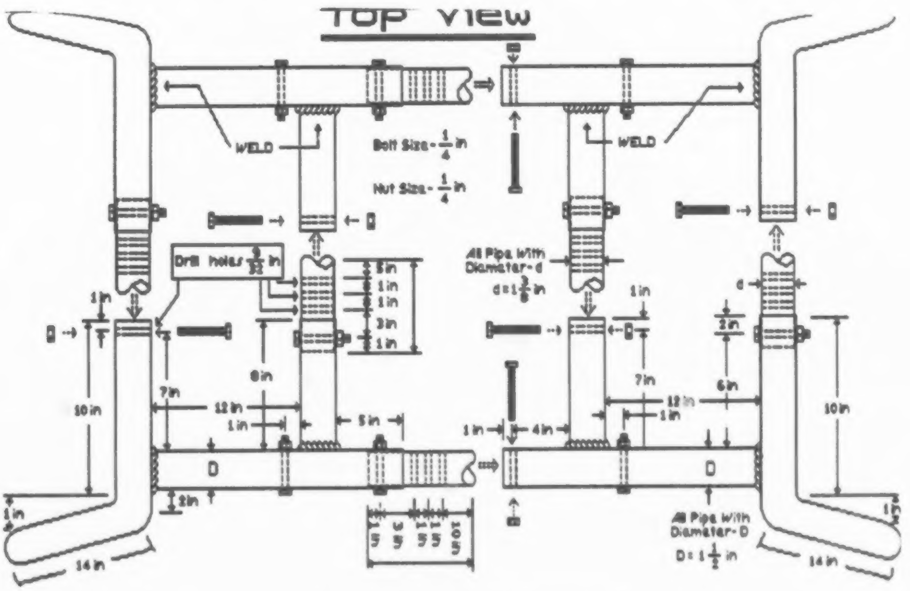
Taking into account the client's physical limitations and planned therapy, it was decided that she needed a device to aid in her therapy by improving balance and muscle control. The device chosen, based on the client's limitations, was a four-point position crawler. The crawler is composed of four multi-adjustable legs and supporting structure, a harness assembly, and a wheel assembly.

The crawler's legs span above the client and then arc down to create a supporting structure for the harness assembly and client. The legs and supporting structure are made of 1 5/16- and 1-inch steel tubing. The different pipe sizes are to allow enough of a clearance to produce a sliding fit, thus allowing for adjustability in length, width, and height. This adjustability accommodates the growth of the client and also the possibility of the crawler being used by another handicapped person. The crawler was designed with safety features such as a safety belt to hold the client in place, and legs that are designed wide enough to keep the wheels out of reach of the child. The crawler is adjustable in height from 10 to 13 inches. The wheels are 31 inches apart from side to side and 23 inches apart from front to back. The maximum yield strength in the legs is 54 ksi allowing a maximum load of 90 pounds.

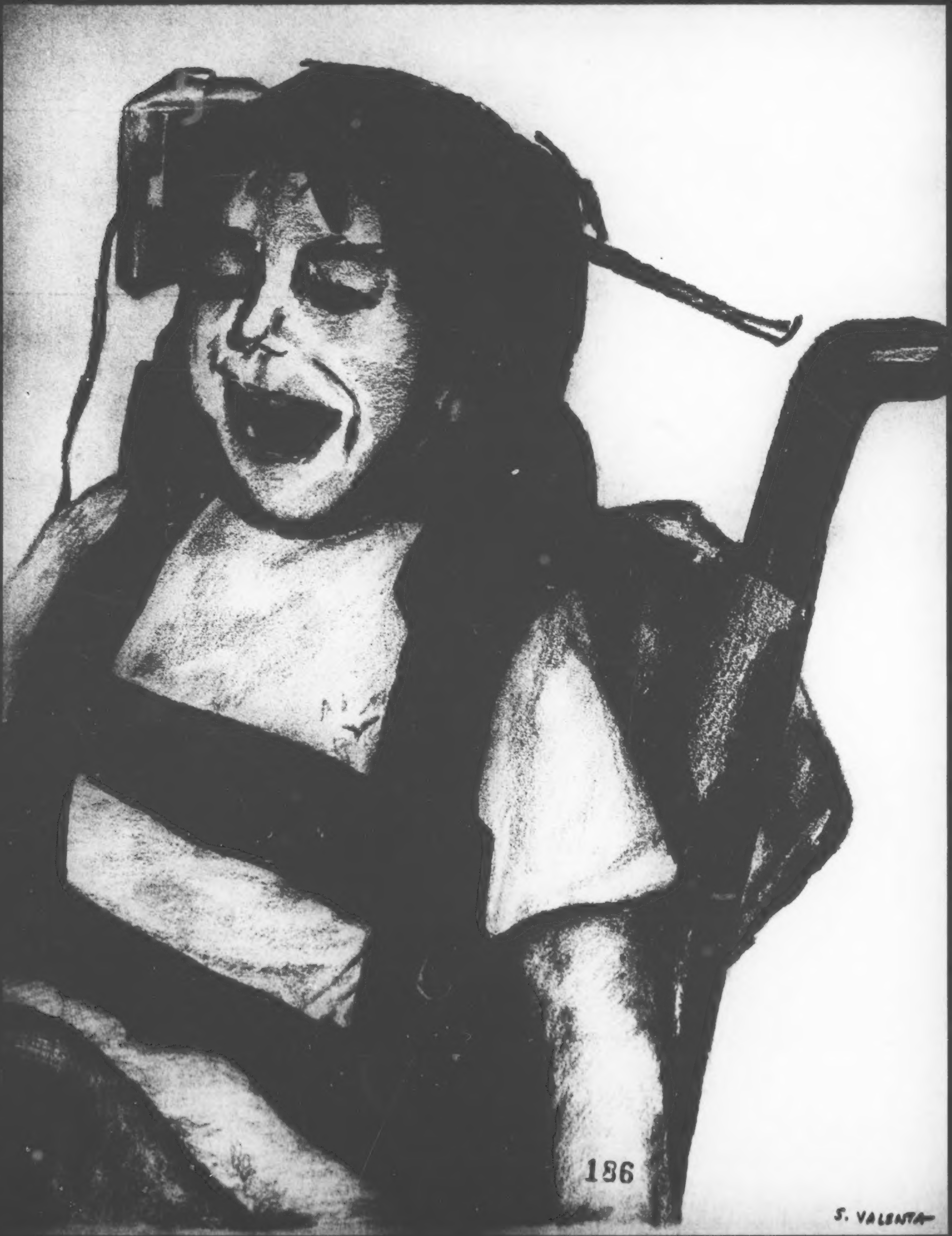
The harness assembly maximizes comfort and support, thus potentially increasing the time spent in the crawler by the client. The harness consists of a 3/8-inch steel plate fitted with a cushion and supported by straps attached to the supporting structure. These straps are adjustable using buckles and clasps.

The wheel assembly includes roller-ball caster wheels as opposed to thin, flat caster wheels. Roller-ball caster wheels facilitate maneuverability on flat surfaces, indoors as well as outdoors. The wheels also have covers around them to prevent the client from rolling the crawler over her hands while crawling.

The Senior Projects' student time spent on design, fabrication and testing was 102 hours. Less than $200 was spent on materials and supplies.



Top Half Symmetrical to bottom Half


S. VALENTA

CHAPTER 10

TULANE UNIVERSITY
SCHOOL OF ENGINEERING
DEPARTMENT OF BIOMEDICAL ENGINEERING
NEW ORLEANS, LOUISIANA 70118

Principal Investigators

David A Rice (504) 865 5897

Ronald C. Anderson (504) 865 5867

THE CO. JONES FEEDER

Designers: Jorge Acevedo; Hector Badia; Octavio Carreno;
Philip Fitzpatrick; Jim Toledano
Therapist: Roberta Torman, LOTR, Children's Hospital
Supervising Professor: David A. Rice, Ph. D., P.E.
Department of Biomedical Engineering
Tulane University
New Orleans, LA 70118

INTRODUCTION

The Co. Jones feeding device is designed for use by a C1-C2 quadriplegic with incomplete transection. The feeder moves a spoon with three orthogonal axes of motion that are controlled independently. The process is controlled by an arm lever and a headset with mercury switches. The arm lever is triggered with slight up or down movement. The patient has good head motion to the sides and front and back, facilitating operation of the headset switches. With this device the patient can pick up food from anywhere on a stationary plate. Alternatively, a pencil or other instrument can replace the spoon permitting the client to draw on paper or manipulate other items.

SUMMARY OF IMPACT

This device was designed for use by specific client who has recently died. Independently, Children's Hospital selected it for testing and use in their occupational therapy department.

The design is adaptable to other patients' specific needs by using other switches in place of the original set. The feeder has been demonstrated with soft and particulate foods such as pudding, red beans and rice, jambalaya, peas, and cake.

Co. Jones Feeder. Note 4-bar spoon and pencil holder. Cap contains mercury switches to control spoon translation.

TECHNICAL SUMMARY

This feeder was designed so that a spoon can be moved in all three directions in space. This is achieved through the use of three separate driving systems: one for forward or reverse, one for left or right, and one for up or down. Mercury switches in a headset and a momentary contact switch on the unit provide the control.

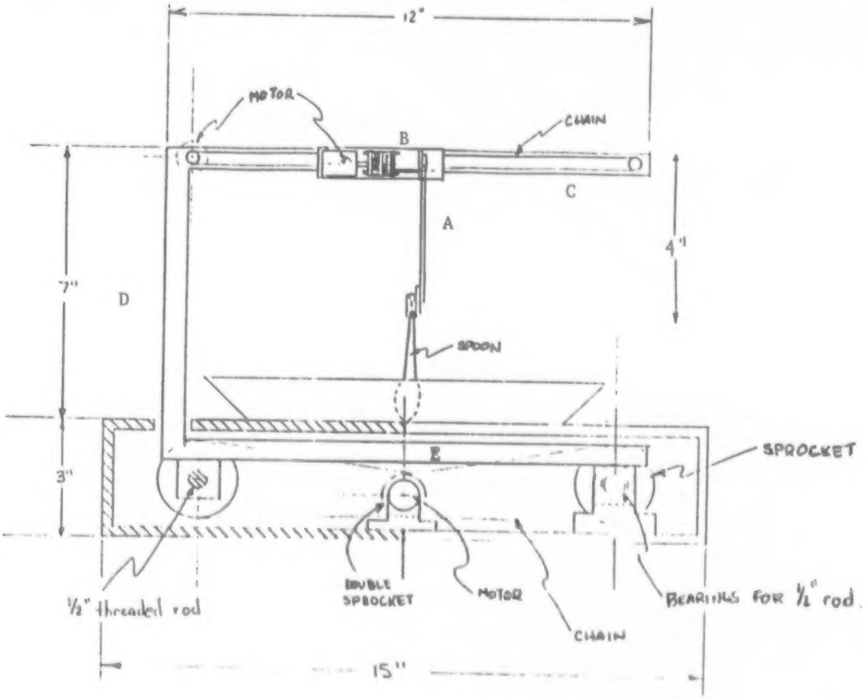
The figure shows the basic mechanism that includes a spoon, a four-bar mechanism (A), a trolley (B) on crossarm (C) that mounts on a vertical support (D). The vertical support fastens to the base trolley (E) that is hidden in the base of the unit.

The spoon connects to the elevating motor through a four-bar mechanism that keeps its bowl level. The elevating motor is carried on a trolley in the crossarm to provide right and left motion. A belt and pulley system moves the crossarm trolley.

The base trolley provides the forward and reverse motion by a chain and sprocket driven screw drive. The chain system is necessary in order to keep the two drive screws synchronized. Limit switches protect the feeder from jamming or damage.

Safety features include low voltage operation of 12 volts from a breaker protected line power supply and interlocks to prevent the mechanism from working if the base is opened.

Cost of the prototype is $310, but analysis of the design suggests that this could be reduced considerably by minor material and design modifications.



Frontal section of Co. Jones feeder.

THE LNS FEEDER
A CONTROLLABLE FEEDING MACHINE FOR USE BY PEOPLE WITH MOTOR OR ARTICULATORY DIFFICULTIES

DESIGNERS:John Ammon; Frances Balding; Rachelle Meaux; Theodore Paxton
Therapist: Geralyn Giffin, LOTR, Children's Hospital
Supervising Professor: David A. Rice, Ph. D., P.E.
Department of Biomedical Engineering
Tulane University
New Orleans, LA 70118

INTRODUCTION

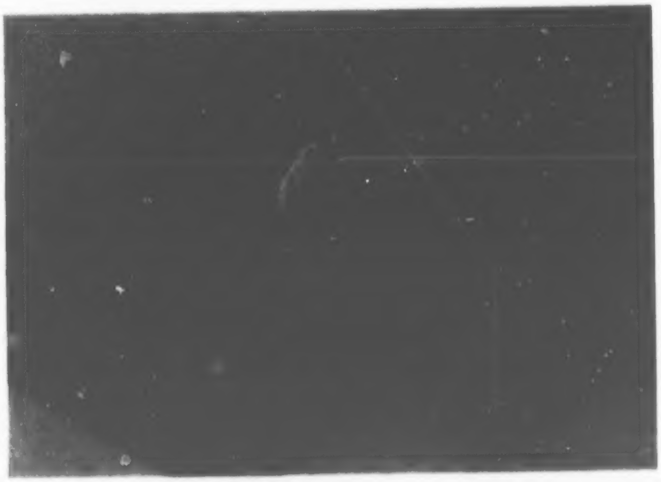
This feeding device is designed to assist the handicapped in their pursuits to lead a normal life. The feeder is joystick controlled, and can be run either on batteries or by line current. It is built of wood and is covered with formica for ease in cleaning. The plate of the feeder moves left to right, and the arm move forward to scoop up food and bring it to the mouth. The arm is hooked to a spring that helps to raise the food smoothly. A wide variety of foods may be eaten with this device, but items such as meat need to be cut first.

We designed the LNS feeder to enable a five-year-old girl afflicted with arthrogryposis to feed herself. The current controller is a joystick, but other controllers may be substituted to adapt to other types of disability.

SUMMARY OF IMPACT

Our client's therapist notes that "She has adapted very well to her feeding device, even though she displays decreased range of motion and muscle strength in both upper extremities. She uses her upper right extremity to operate the joystick". Our observations of our client have led us to believe that she enjoys operating the feeder, and is very enthusiastic about being able to feed herself now.

With this feeding device, our client will have more control over her environment and thus gain some of the independence necessary for proper psychosocial development, as well as relieving her family of some of the burden of caring for her.



The LNS Feeder

TECHNICAL DESCRIPTION

The LNS Feeder simplifies the process of moving food from a plate to the mouth. Normal eating with a spoon requires motion with at least four degrees of freedom (motion along or about four axes). The minimal set of motions is: 1. rotation of the spoon to pick up food, 2. right and left motion to select food, 3. back and forth motion to scoop food, and 4. up and down motion to transport the food from the plate to the mouth. We reduced these motions to two degrees of freedom in order to simplify the device and make it easier to control.

The plate with the food moves to the right and left under direct joystick control. A spoon on a moveable arm moves forth and back under direct joystick control.

The other two degrees of freedom are avoided as follows. When the spoon reaches the near edge of the plate, a mechanism raises it automatically to mouth height and presentation position for eating. Spoon shape and the shape of the near edge of the plate obviate the need of the scooping motion for food pickup.

The LNS Feeder consists of four main parts: A base unit that contains the motors and control circuitry, a moveable (and removable) plate for food, an arm that holds a spoon, and a joystick for control.

Base Unit

The base unit is sturdily constructed of wood and covered with plastic laminate. It maintains a low and unobtrusive profile to enhance social acceptability. It contains the circuitry, motors, and mechanical systems. Two gearmotors drive the device by pulling the plate and arm mounts along guiding tracks. Limit switches prevent the motors from grinding when motion extremes are reached. Power is provided by a 12 V line powered DC supply or an auxiliary battery pack.

Plate

The plate is formed by cutting and heat forming part of a standard plastic (Tupperware) container. Hook and loop (Velcro) fasteners attach the plate to the plate mount. Markings permit visual alignment when fastening. This makes the plate easily removable for washing or serving.

Arm and spoon

The arm mounts on a trolley that slides along a track hidden in the base. The arm itself is a four bar mechanism that keeps the spoon level at all times. The spoon is normally lowered to slide on the plate, but when it nears the front edge of the plate an internal linkage pulls the mechanism to its elevated position.

Joystick

The joystick is a familiar and standard device commonly used for playing computer games. It is connected to the circuitry in the base unit by a standard DB-9 connector. Since its operation is on or off, rather than proportional control, it could be replaced with another set of control switches that can be individualized for each user. Even with individual controls, the feeder could be shared among several users.

Cost

The total cost of this prototype, excluding labor, is $ 275. If it were put into production the cost would be reduced considerably.

FJJ Self Feeder
A MECHANICAL FEEDING MACHINE FOR VICTIMS OF ARTHROGRYPOSIS

Designers: J. Baldwin, J. Pascarella, and F. Ali
Therapist: Dianne Patterson, LOTR, Children's Hospital
Supervising Professor: David A. Rice, Ph. D., P.E.
Department of Biomedical Engineering
Tulane University
New Orleans, LA 70118

INTRODUCTION

Being able to eat in a social setting is crucial for the proper development and happiness of any person. Many handicapped children cannot feed themselves unaided, use, or afford commercially available machines.

There are several feeding machines currently available from commercial manufacturers that are inappropriate for individuals with arthrogryposis. Some are motorized, requiring a source of power that may not always be available, and some are mechanical. The mechanical devices are cheaper, but still cost about $600. These are suitable for many, but are not always adaptable for a given individual's range of motion or for the intelligence, size, and strength of a child.

We designed the feeder for a specific client, Lindsay, a four year old who cannot bend her elbows or raise her arms. She has difficulty moving her arms medially, but does have good gripping ability with one hand and can push and pull with shoulder and body action.

The primary goal is to design a machine that is effective, portable, rugged enough for use in a kindergarten cafeteria, and as unobtrusive as possible. Secondary goals include low cost, obvious principles of operation, and maximum adaptability.

SUMMARY OF IMPACT

Lindsay learned to use the machine with coaching on her first session. Colored dots placed on the base and handle worked well as a teaching tool to show proper positions for scooping and food presentation. She can eat pudding, grits, mashed potatoes, and spaghetti. Use with particulate food is made possible by increasing the slope of the plate edges. She has had the machine for several months and eats two or three meals a day with it.

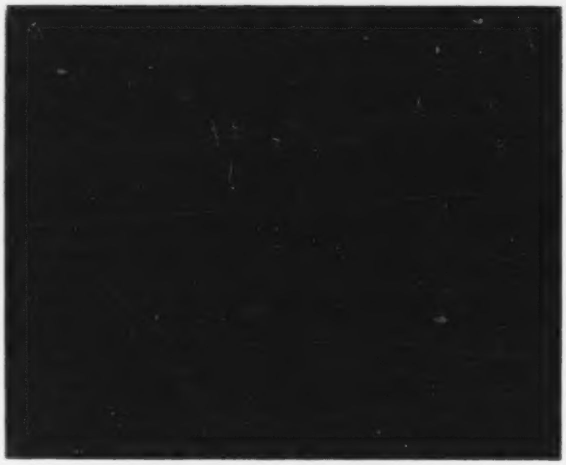
FJJ Self Feeder- front view

TECHNICAL DESCRIPTION

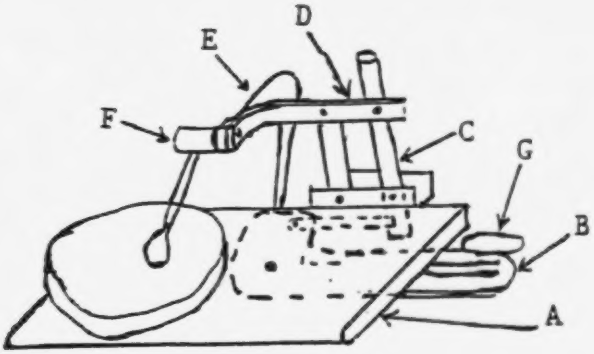
Our design starts with a 9" by 13" wood board (A) stabilized by suction cup feet. A pie plate is fastened with Velcro to a lazy-susan bearing that permits plate rotation. A lever (B), mounted on the underside of the board pivots an upright (C). The upright is paired with a second to support a beam (D) on pivots. This arrangement keeps the beam horizontal as the lever raises and lowers the assembly.

The spoon is rotated by turning a handle (G) at the end of the lever. A cable (E) transfers this motion to a spool (F) mounted at the end of the horizontal bar. When the spoon is pushed into the plate it sweeps along a radius from the center and is held level at the volition of the user. Spoon rotation is limited to protect the mechanism and to keep the spoon in its useful range.

The parts are designed to be assembled for either a right- or lefthanded person, and are made from aluminum to ensure easy machinability, corrosion resistance, and light weight. The lever and cable arrangement is not limited to the current configuration. They may even be made detachable for foot operation, but this is beyond the scope of this work. We estimate that the cost of fabricating the feeder, in small quantities, to be about $300.



FJJ Self Feeder- back view



FJJ Self Feeder- x-ray view

AUTOFEAST

A Self Feeding Device for C2-C3 Quadreplegics

Designers: Mark Cardinal; Jeff Hoffman; Peter Kim; Ray Shashaty
Therapist: Dianne Patterson, Children's Hospital
Supervising Professor: David A. Rice, Ph. D., P.E.
Department of Biomedical Engineering
Tulane University
New Orleans, LA 70118

INTRODUCTION

The Autofeast self-feeding device will give handicapped individuals, particularly quadriplegic with little movement, the freedom to feed themselves. The design is simple and allows an individual to move food from a plate to his mouth with a single chin control. When the mouth is closed, the spoon moves back to a resting position, and the plate begins to rotate, giving the individual a choice of what to eat next. The user then opens his or her mouth causing the spoon to move forward. The spoon scoops food off the plate and continues moving toward the mouth. Once inside the mouth the spoon stops until the user closes his or her mouth and the spoon pulls out leaving the food behind and returns to the resting position.

SUMMARY OF IMPACT

The feeder was designed for a nine-year-old C2-C3 quadriplegic who lacks complete tongue control and has motion limited to facial expression and jaw position. The Autofeast device will improve the independence of the user during meals and will relieve some of the burden of caring for him from his family. As of this writing, the prototype shown has been successfully demonstrated with a variety of foods and will be released to the client as soon as the safety review is completed.

Autofeast Feeder. Note cap with chinswitch.

TECHNICAL SUMMARY

The Autofeast self feeder is designed for an individual with extremely limited motion. As such, it must carry out the normal functions of a spoon without direction, responding only to the user's commands from the chinswitch to proceed.

The feeder consists of four active parts: a motorized plate holder, a cantilevered feeding beam that supports a spoon trolley, a spoon guiding system, and a control system. These parts are supported by an adjustable vertical post with a base that rests on a table or across wheelchair arms.

The plate holder is cantilevered from the post. It contains a gearmotor that turns a lazy susan bearing with a friction drive at adjustable speeds of 10 to 30 rpm. A plate is fastened to this bearing with hook and loop fastener. Four removable guide pins assist in initial positioning of the plate since centering on the bearing is necessary.

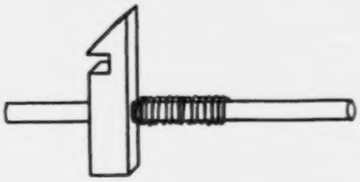
The feeding beam is formed from square aluminum tubing and contains the drive system. The spoon trolley slides in a slot milled in the underside of the beam and is pulled along by a chain and sprocket assembly driven by a gearmotor.

A spoon holder pivots on the spoon trolley and rises and falls as it follows a track suspended from the feeding beam. The track is carefully shaped to constrain the spoon to follow the contour of the plate. When the spoon reaches the front edge of the plate, the spoon rises and latches in its elevated position. It remains elevated during food presentation, and is released only when the trolley returns to its rest position. Thus the spoon has only one degree of freedom with two states and moves forward and backward between the resting position and the user's mouth.

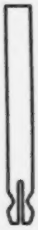
The control system consists of a single 4PDT relay, two limit switches, and a command microswitch mounted under the chin on a headband. The control system and the motors are powered by a single 12 VDC breaker protected line powered supply. A power pilot light is provided for the user for help in diagnosis of malfunction. Sturdy construction and simple design should make mechanical malfunctions very rare, but electric problems are more likely. These will be due to incomplete connection of the user managed electrical connectors of the power and control systems.

Safety is enhanced by using low voltages to power the feeder and enclosing all mechanical parts that could cause injury.

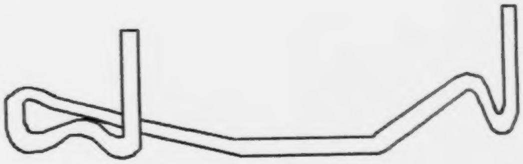
The Autofeast self-feeding device is simple and can be constructed with a limited number of parts of relatively generic nature. The approximate cost of this project, excluding the cost of the time invested, is $150.00.



Latch hook with return spring for holding spoon raised.



Pin for attaching spoon trolley to drive chain.



Track for guiding spoon holder. The reverse bend on the left (rear) engages the latch release on the spoon trolley.

SPUD SPOONER FEEDING DEVICE
A feeding device for quadriplegics with limited finger motion

Designers: Jeanette E. Dalton; Z. Maria Oden; Salena D. Zellers; Andrew Zerkle
Therapist: Peter Fayard, Children's Hospital
Supervising Professor: David A. Rice, Ph. D., P.E.
Department of Biomedical Engineering
Tulane University
New Orleans, LA 70118

INTRODUCTION

The Spud Spooner enables a person to feed himself if he has control over the movement of the fingers on one hand. This would include disabilities such as a person in a body cast or a person with two broken arms, someone that has locked elbows or even a quadriplegic with slight movement in the fingers. The feeder allows the person to eat all types of food as long as it is either in bite-size pieces or is of a soft or semi-solid texture. Three color-coded switches operate this feeding device. Those switches are easy to control and will operate the actions of the plate and spoon. All the movements of the Spud Spooner are designed for user compatibility and ease of adjustment such that control over eating can now be enjoyed by those people who otherwise are dependent upon others for every daily activity.

SUMMARY OF IMPACT

Children's Hospital has selected the Spud Spooner for use in the Occupational Therapy department for patient evaluation and for training in the ADL laboratory.

The Spud Spooner. Note the attractive wooden construction and the split spoon.

TECHNICAL SUMMARY

The Spud Spooner consists of a special spoon, a lifting arm, and a translating and rotating plate that are set in an aesthetic base. The arm, spoon, and plate are moved by the coupled action of several motors that are currently controlled by three momentary contact switches.

The Spud Spooner uses a unique spoon that is split down the center and opens and closes like a crayfish claw. This approach handles many of the problems common to mechanical feeders by permitting the spoon to remain level at all times and by facilitating food pickup without requiring a pusher or backstop.

The lifting arm is a four-bar mechanism that keeps the spoon level. The plate is mounted on a platform that translates right and left and rotates.

The motors and control circuitry are hidden in the attractive wooden base for safety and aesthetic purposes.

Operation

The control interface uses double throw momentary contact batwing switches. These are mounted on a box that fastens to the base but can be positioned anywhere. The circuitry can easily be modified to use single throw switches with toggling relays if the client cannot operate the original switches.

The first switch controls the spoon and the arm. Pulling the switch causes the spoon to close around or on the food. This action then initiates raising the arm and spoon to the presentation position. Pushing the switch opens the spoon and lowers it to the plate. This design keeps the arm mechanically simple and the control easy and straightforward.

The other two switches control the position and orientation of the plate. Since the spoon always returns to the same position relative to the base, moving the plate permits food selection from anywhere on it. This operation requires two degrees of freedom, but the plate could be moved continuously by an automatic mechanism. This allows the user random access by timing the spoon motion appropriately.

Safety is enhanced by enclosing all hazardous mechanisms and using low voltage (12 V) for power. The feeder may be operated using either batteries or a mains power supply.

The cost of this device, excluding R and D and labor, is $150.

SPINAL EXTENSION CHAIR FOR USE IN CASES OF MYELOMENIGOCELE

Designers: Ronald Mosrie, Marta L. Villarraga
Therapist: Geralyn Giffin, LOTR, Children's Hospital
Supervising Professors: David A. Rice, Ph.D.,P.E. and
Ronald C. Anderson, Ph.D.
Department of Biomedical Engineering
Tulane University
New Orleans, Louisiana 70118

INTRODUCTION

Myelomenigocele is a spinal formation defect whereby the neural arches of the vertebra do not close properly. This can result in the protrusion or damage of the spinal cord, leading to severe neurologic degeneration. While this affliction can be catastrophic, in many instances it is possible to rehabilitate an affected child and return some degree of ambulatory freedom. Much of the therapy necessary to accomplish this is in the form of postural exercise, where the extensor muscles of the lower spine and upper leg are required to maintain position. These muscles are also critical to trunk support and knee extension during ambulation. One way in which postural exercise can be achieved is to have the child sit with an anteriorly rotated pelvis. This position forces the spine into extension, and can be achieved with a seat that that is tilted forward. The purpose of this project was to design, build, and implement such a chair so that the client could get the needed exercise during ordinary daily activities.

SUMMARY OF IMPACT

As of the date of this report, the chair (Figure 1.)has been in the possession of the physical therapy clinic at Children's Hospital for the initial trail and observation of the intended client. The physical therapists have reported a generally satisfactory result in that the client was able to comfortably maintain an anterior pelvic rotation and spinal extension. It was remarked that the client was "doing beautifully" and "really liked the chair". However, the child has grown since the original design was initiated and some of the dimensions of the chair require modification at this time. More importantly, it is now apparent that the original intention to have the child kneel on a padded rest in order to partially support her weight is not feasible from the standpoints of comfort and postural control. Apparently that the child's knees should be extended to encourage use of the quadriceps. Thus, the chair has now been returned to the Department of Biomedical Engineering for second generation design changes.

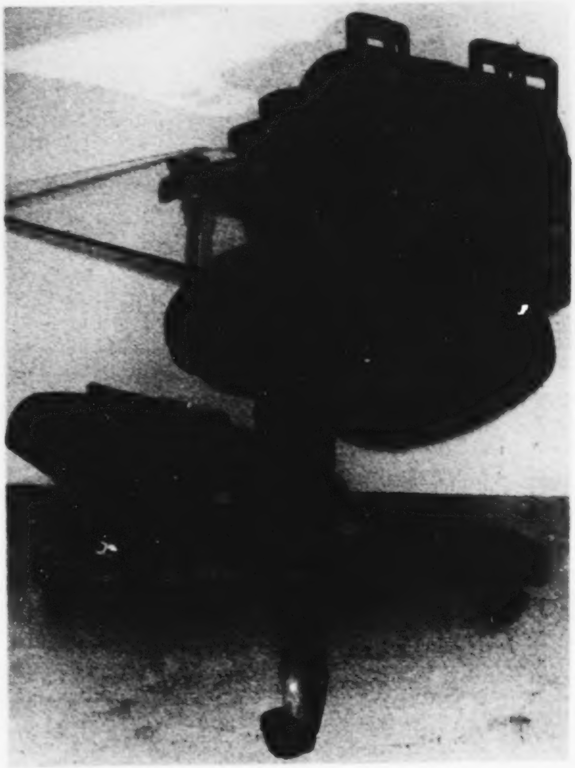


Figure 1. Spinal extension chair

TECHNICAL DESCRIPTION

The chair is modified from a knee chair of the Balans design. The seat consists of a broad foam-filled cushion tilted forward approximately 10°. Knee cups were strapped to a similar foam-filled knee rest to provide stable, cushioned knee support. The chair back is intended to provide broad thoracolumbar support in an upright, lordotic position. Two encircling steel brackets, welded to the chassis, have foam-filled pads attached on either side to give adjunct lateral support. The chair back, seat, and knee rest are mounted on a welded chassis and attached to a base with casters so it can be easily moved from room to room. Steel brackets are welded to the chassis to which a clear acrylic tray can be clamped to provide a playing surface for the child during the time spent in the chair.

Since it is anticipated that the client will be only able to support a large portion of her weight on an intermittent basis, slotted steel uprights are welded to the chassis above the chair. This allows nylon straps to secure a plastic chest harness to prevent the client from falling forward as she tires. A modified automobile safety belt is included as well, in order to prevent the child from slipping out of the chair.

The approximate total cost of this project was $200.00. We feel that the this design is simple, easily manufactured, and above all, effective in providing postural therapy in a non-clinical environment.

MOTORIZED TRICYCLE

Designers: Bob Newhard and William Gooding
Therapist: Roberta Torman, Children's Hospital
Supervising Professor: David A. Rice, Ph. D., P.E.
Department of Biomedical Engineering
Tulane University
New Orleans, LA 70118

INTRODUCTION

One of the major problems the young paraplegic faces is the difficulty in using some toys and in playing with his or her peers. This reduces the child's chances to learn valuable social skills and can impair physical, cognitive, and emotional development. The purpose of this project is to adapt a common tricycle so that it can be used by a child with lower extremity paralysis. The device consists of three modules: a seat, a propulsion unit, and a speed controller. The design emphasizes safety, utility, and portability.

SUMMARY OF IMPACT

Children's Hospital has received this device for the Department of Occupational Therapy. They will use it in house to evaluate their clients and will release the tricycle to suitable clients for long or short term loans, as is deemed appropriate.

Assembled tricycle showing seat, controls, and controller and battery housing.

TECHNICAL DESCRIPTION

We planned to augment a tricycle with as little modification as possible because acquiring standard equipment minimizes cost and maximizes reliability and repairability.

The system is divided into modules: the seat, the propulsion unit, and the controls. The modular design permits fast field assembly and enhances portability since each piece is compact and the tricycle itself does not need to be carried if one is available at the destination.

Attachments to the tricycle are made with screw operated hose clamps. Only a screwdriver is required for assembly, and no modifications to the tricycle are needed.

Seat

The new seat is a standard add-on child seat made for use on a bicycle. The tricycle seat supports the weight, and a simple tubular A-frame fastens it to the rear axle. This provides both lateral and longitudinal stability. The harness that comes with the seat keeps the child from falling.

Propulsion Unit

As shown by the figure, the propulsion unit looks much like a skateboard. A slot in the center receives the front tricycle wheel which is held in place by gravity and does not touch the ground. This prevents the wheel and pedals from rotating. The rear of the board is supported by two ball casters that permit the tricycle steering to work.

An electric gearmotor drives a standard skateboard wheel. This wheel is remounted so that it is fixed on its axle and its two bearings support the driven axle. Two specially machined pillow block mounts position this drive wheel in line with, and just in front of the front tricycle wheel thus supporting most of its weight and causing the steering to be self-centering. The motor is powered by a 12 volt rechargeable gel-cell through an external line powered charger.

Controls

Control is provided through a switch and a lever. These are mounted on the handlebars with screw operated hose clamps.

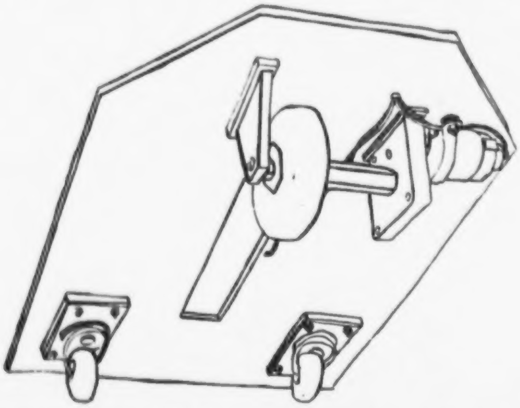
The double throw momentary contact switch determines the direction of motion, permitting the device to proceed both forward and backward. The switch is moved in the direction of the proposed motion to activate the motor. This makes the device usable with minimal training. When the switch is released, the motor stops.

Forward speed is controlled by a lever actuated Bowden cable, a standard bicycle brake lever and cable. This cable operates a series rheostat that is mounted on the propulsion unit. A spring returns the control to its lowest speed when the lever is released. Top speed is 1/2 mph and it may be reduced by the parent or therapist using a child-resistant screwdriver control mounted on the propulsion module.

Reverse allows the child operator to get out of tight spots, and is limited to a single low speed. To enhance safety, both forward and reverse speeds are limited so that the child is unlikely to damage him or herself or other objects by hitting them.

Cost

The straightforward design, simple construction, and use of standard mass produced components make this device relatively inexpensive to manufacture. Total construction costs are about $100 for small quantities which makes the device affordable to many families.



Tricycle propulsion unit showing motor, drive wheel, slot, and casters.

DIAGNOSTIC TRANSDUCER TO MONITOR DEFECT MATURATION IN LIMB LENGTHENING PROCEDURES

Student Designer: Brad Rohr
Attending Physician: Michele M. Zembo, M.D.
Supervising Professor: Ronald C. Anderson, Ph.D.
Department of Biomedical Engineering
Tulane University
New Orleans, Louisiana, 70118

INTRODUCTION

Limb length discrepancy in children can result from a number of pathologies including congenital deformity, severe osteomyelitis, achondroplasia, and trauma to the growth plate or afflicted bone. The extent of the discrepancy can be such that severe physical and emotional disabilities result. In some instances it is possible to use circular external fixation frames to correct severe limb shortening or angular deformation. This operation requires that an osteotomy be created at some point within the viable bone tissue. The external apparatus is fixed to the two fragments of bone via thin transfixing wires which pass through the bone and surrounding soft tissues to attach to the frame. It then becomes possible to slowly distract the two bone segments by lengthening the frame. The tissue that forms in the gap created begins as a soft tissue which must undergo maturation and calcification to become functional bone. The formation of the defect tissue is greatly dependent upon distraction rate, but it is difficult for the surgeon to assess the status of the maturing tissue non-invasively in order to provide optimal deformity correction. The purpose of this project was to create a transducer (shown in Figure 1) which can easily attach to an external frame and assess the maturation of the defect tissue, taking advantage of the the fact that the material stiffness gradually increases as the tissue matures.

SUMMARY OF IMPACT

At present, the prototype of the transducer is fully operational and is being used in the laboratory to correlate the level of transverse force at the defect (in response to a moment applied to an aluminum replica of a tibia) to the stiffness of the material "filling" the space between upper and lower pieces of the fixture. The results indicate that the transducer is capable of identifying the difference between material with a stiffness of fibrous tissue and material with a stiffness corresponding to 10% dense cancellous bone at low levels of applied moment. This suggests that the device will be able to identify the point where the precursor soft tissues begin to differentiate into calcified tissue, and thus allow the surgeon to assess the lengthening procedure. It has also been demonstrated that the transducer can identify differences in materials of stiffnesses corresponding to mature and immature bone. Thus, the device will be useful in determining when healing is adequate and when the device can be removed without fear of refracture. The current transducer will be modified with a skin pad and will be used to evaluate patients at Children's Hospital on a preliminary basis this fall.

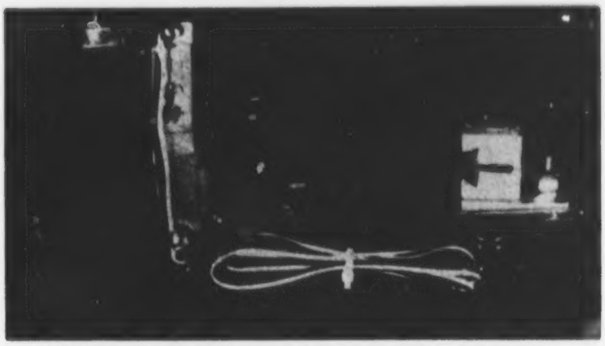


Figure 1. The diagnostic transducer. The strain-gaged cantilever component is located in the upper left corner.

TECHNICAL DESCRIPTION

The sensing device consists of a small aluminum cantilever beam to which a 120Ω uniaxial strain gage is bonded. The gage was incorporated in a quarter-bridge circuit to a strain gage conditioner which can be nulled to eliminate signals associated with initial preload upon placement. The beam is rigidly fixed to an adjustable support bracket on one end, and currently has a cyanoacrylate bonded acrylic knife-edge on the other. This arrangement proved to be quite sensitive in bench tests. The second generation design will employ a pinned pad to interface with the patients skin, rather than the knife-edge.

The support bracket is mounted to slotted extension of an adjustable clamp. The adjustable bracket is designed to allow approximately one inch of radial excursion to account for eccentric variation in the surgical placement of the external frame. The slotted extension similarly provides three inches in height adjustment. And the clamp is so designed to allow its application to any point on the ring components of the external frame. The ability to provide precise placement of the transducer is critical to its effective application as a monitor of the condition of a specific location on the surface of the affected limb.

The total cost to produce this device was approximately $50.00. The transducer is a simple and effective way of non-invasively obtaining a quantitative measurement of tissue maturation, and provides the surgeon with information that has been previously unattainable.

WEIGHING DEVICE FOR QUADRIPLEGICS

Designer: Michael Voor
Therapist: Nora Steele, RN, MN, Children's Hospital
Supervising Professor: David A. Rice, Ph. D., P.E.
Department of Biomedical Engineering
Tulane University
New Orleans, LA 70118

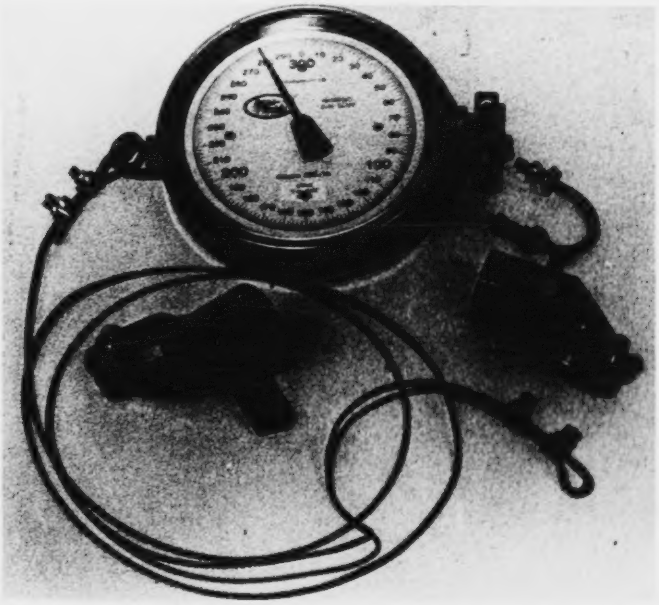
INTRODUCTION

Careful monitoring of body weight is necessary for health maintenance of paralyzed people. Home weighing of children can be done by having a parent hold the child while standing on a scale, then subtracting the parent's weight. This is cumbersome ordinarily, but when the child gets too large to do this, the need for weighing may be the final reason for institutionalization of the child.

Most families with a paralyzed member will have a hoist to lift the patient from bed to bath or chair. By fitting the hoist with a scale, weighing can occur without difficulty. This device is designed as a kit that can be attached to commercial hoists (such as a Hoyer lift) with simple tools and no modification of the hoist itself.

SUMMARY OF IMPACT

This weighing device was designed for a quadriplegic on a ventilator who lives some distance from Children's Hospital so that frequent travel for routine weighing is beyond the family's means. The device was used successfully in the client's home until her untimely death, and has now been delivered to another quadriplegic client. As of this writing there are no reports from the new recipient.



Prototype scale kit. Safety upgrades are described in the Technical Description.

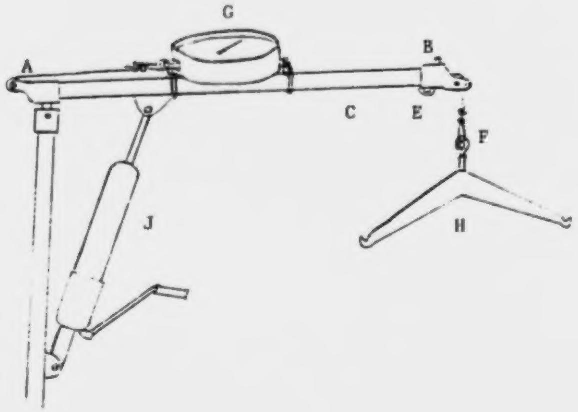
TECHNICAL DESCRIPTION

A spring scale attaches to the hoist boom with U-bolts in a place that is comfortable for viewing. Two ball-bearing pulleys guide a 1/8 in stainless steel aircraft cable from the scale through the boom to the cantilevered end. The pulleys are supported in brackets that fasten to the ends of the boom. A new cable eye is formed near the existing eye of the boom where the patient sling usually attaches. By hooking the sling to the cable eye, the patient's weight is transferred via the cable to the scale, and the reading can be taken. The device can be left attached to the hoist since it doesn't interfere with normal operation.

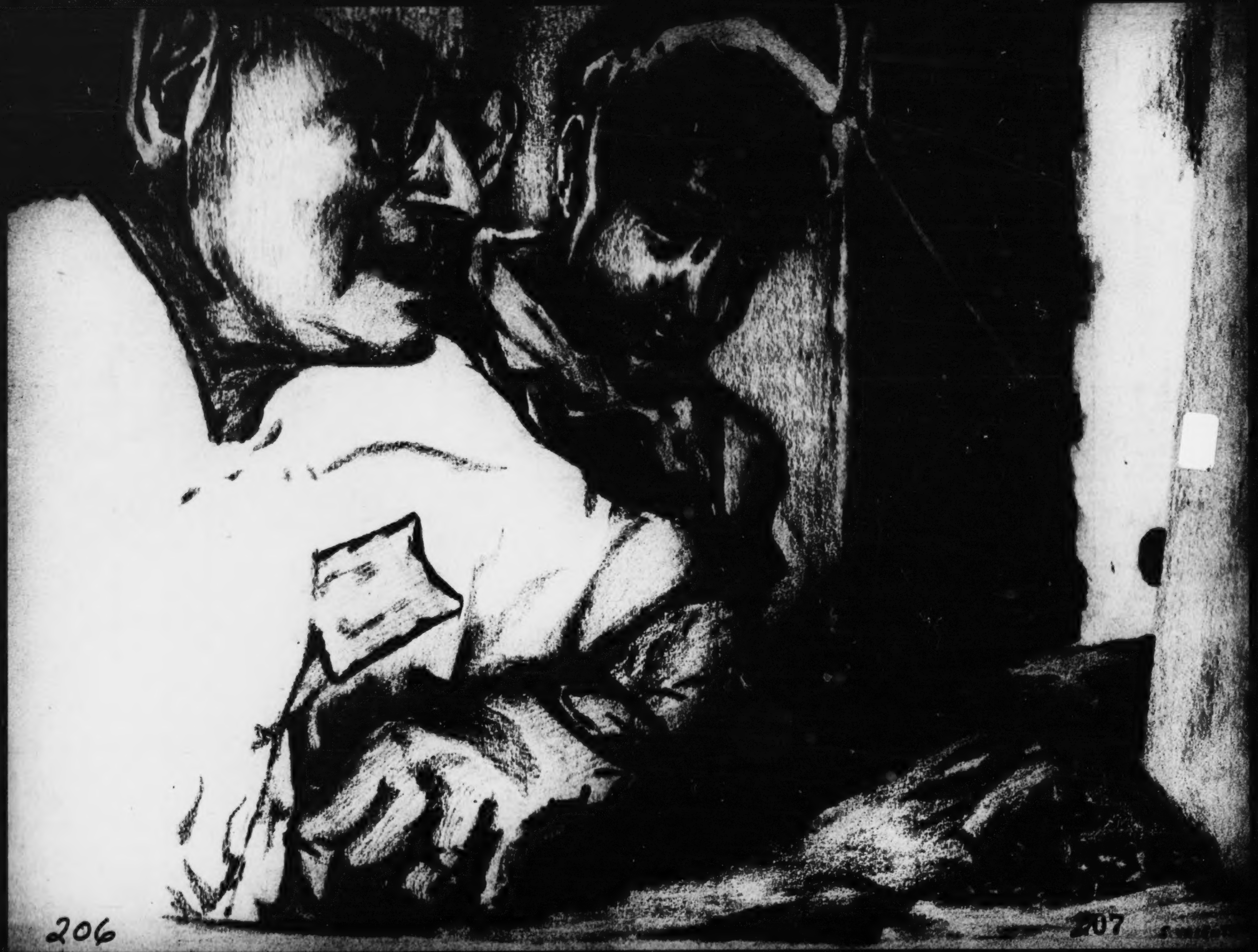
Several features enhance safety. All parts were designed with a safety factor of three or greater. The brackets that support the pulleys have set screws, but the load forces them onto the boom. The cable eyes are shown formed in the cable by the photograph, but the design has changed after the photograph. Now they are made with stainless steel rigging eyes that are swaged onto the cable. A safety chain runs from the new sling eye to the old sling eye, supporting the patient if any part of the cable, scale, or linkage should slip or fail. The open construction permits visual inspection of critical parts. A Safety and Operation manual given to the patient's family describes these features and advises periodic checks to maintain a high level of reliability.

The accuracy of the system is limited by accuracy of the scale, friction in the cable and pulley system, and calibration procedures. This system, as opposed to a strain gage approach, performs independently of boom angle or elevation. Tare weight, the weight of the sling and other patient accoutrements, can be adjusted at the scale so that true patient weight is shown. The calibration for this is described in the Safety and Operation manual. The system shows an error of less than 1 lb with use of a special dithering procedure (described in the manual) to reduce the effect of friction and less than 3 lb otherwise.

The cost of the weighing system is less than $200, much less than other systems that provide comparable results.



Weighing system as mounted on a hoist. The figure shows the pulleys and brackets (A, B), hoist boom (C), boom eye (E), cable eye (F), scale (G), sling (H), and boom jack (J). Not shown is the safety chain.



CHAPTER 11

THE UNIVERSITY OF AKRON
COLLEGE OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING
AKRON, OHIO 44325

Principal Investigator:

Paul C. Lam (216) 375-7741

"Computer Interaction Through Voice Recognition"

Designers: Peter Lopez
Disabled Coordinator: Norma Henson, United Cerebral Palsy
and Services for the Handicapped of Akron (UCPSH)
Supervising Professor: Dr. Paul Lam
Department of Mechanical Engineering
The University of Akron
Akron, Oh 44325

INTRODUCTION

The focus of this design project is to develop a computer interaction through voice recognition system to help cerebral palsy patients in a database processing working environment. The project is accomplished by developing voice commands for the manipulation of input data. The design modeling approaches of this project are:

1) Develop a menu-driven program to manage an employer's payroll system which includes employee, customers, production codes, and timecard data.
2) Apply voice recognition as a mode of computer interaction for the developed software for use by disabled persons.

The results from this design project indicated that a voice-driven system is a vital alternative to other data entry methods in a database processing environment where a handicapped individual is abled to effectively contribute.

SUMMARY OF IMPACT

A computer interaction through voice recognition component (figure 1) has been developed to aid cerebral palsy patients in a database processing working environment. The computer based payroll management system not only provides the opportunity to collect timecard data through voice recognition, but has the added advantage of drastically reducing the time required to manage payroll by comparison to a manual-driven system. From the collection and storage of timecard data to the pay period summary, the process is automated. Although most clients have very unique and individual limitations and many cannot perform simple tasks without the aid of adaptive devices, this project so far has provided two developmentally disabled with improved database educational experiences and real work opportunity. With proper training and voice inputs, many off-the self programs can be easily updated and

Figure 1: Computer interaction through voice component.

used by the cerebral palsy patients. This can create many types of jobs from the surrounding community that UCPSH was not able to obtain previously . It is truly an exciting experience to be able to train and observe a client mastering the skill of using a computer through voice alone. Finally, the experiences learned from the speech patterns of cerebral palsy clients can provide valuable information in advancing technologies concerned with input/output computer interactive systems through voice recognition.

TECHNICAL DESCRIPTION

The project consists of three developmental phases:

1) software development,
2) voice recognition system configuration; and,
3) train cerebral palsy patients.

The software application, written in Microsoft FORTRAN for the IBM PC, or compatible, is developed to automate the payroll management system of UCPSH. The program menu hierarchy is displayed in figure 2. Data is entered from the existing timecards and stored in the program database. From this information, the program will summarize a pay period for a given client.

The voice recognition system configuration used in this project required an IBM PC, XT and AT compatible and a Vecalink Model SRB-LC board of Interstate Voice Products. The SRB-LC voice system consists of an IBM PC short expansion card, microphone, and accompanying utility software. It allows users to control operation of application programs and system functions through spoken commands. The model utilizes speaker dependent recognition. This requires that each operator first train the system to his or her voice for each word or phrase in the vocabulary. Voice templates derived from the spoken words are stored in the system's memory and saved on diskettes for future use. Recognition occurs when incoming speech is matched against the previously recorded templates. The output of SRB-LC is passed onto the operating system as if the data were typed at the keyboard.

The quality of computer interaction is more intensely magnified when used by the disabled whose diminished capacity is often a limiting factor in their ability to communicate. During the training of a cerebral palsy patient to enter daily timecard, a slight modification had to be made in the program vocabulary. This is due to the client's difficulty in pronouncing certain words. In general, the problems encountered in training the cerebral palsy patients are minimal because their speech patterns are both unique and consistent despite the fact that the speech is often impaired. With several training sessions, it was observed that the operator, using the voice recognition program, input daily timecards much faster than the client using the head stylus which is the present mode of computer input for the disabled.

The entire computer interaction through voice recognition unit costs two-thousands four hundred dollars ($2,400) to set up. Different voice cards are tested to improve the present system. One important aspect of the project indicated that a design which takes into account the needs of the disabled can often produce a better application related technology for the 'average' person.

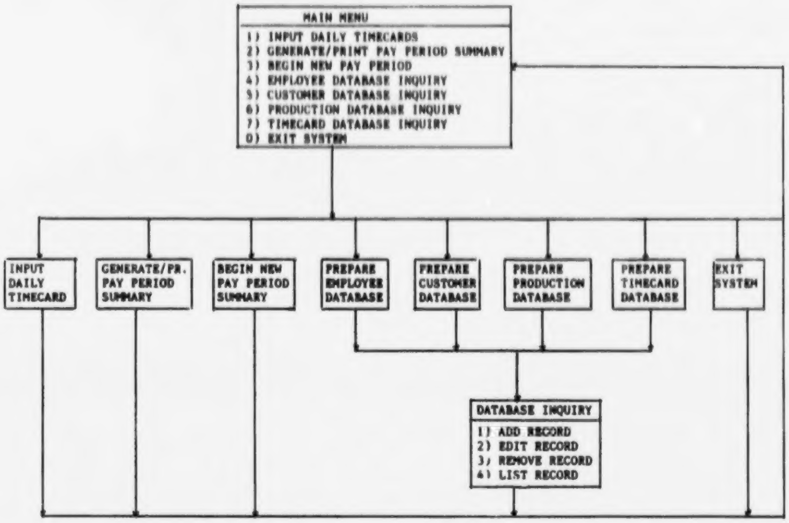

MAIN MENU
1) INPUT DAILY TIMECARDS
2) GENERATE/PRINT PAY PERIOD SUMMARY
3) BEGIN NEW PAY PERIOD
4) EMPLOYEE DATABASE INQUIRY
5) CUSTOMER DATABASE INQUIRY
6) PRODUCTION DATABASE INQUIRY
7) TIMECARD DATABASE INQUIRY
0) EXIT SYSTEM
INPUT DAILY TIMECARD
GENERATE/PR. PAY PERIOD SUMMARY
BEGIN NEW PAY PERIOD SUMMARY
PREPARE EMPLOYEE DATABASE
PREPARE CUSTOMER DATABASE
PREPARE PRODUCTION DATABASE
PREPARE TIMECARD DATABASE
EXIT SYSTEM
DATABASE INQUIRY
1) ADD RECORD
2) EDIT RECORD
3) REMOVE RECORD
4) LIST RECORD

Figure 2: Program menu heirarchy.

"Card Reader"
An Adaptive Sorting Device for the Cerebral Palsy Patient

Designer: Peter Hoge
Disabled Coordinator: Norma Henson, United Cerebral Palsy and Services for the Handicapped of Akron (UCPSH)
Supervising Professor: Dr. Paul Lam
Department of Mechanical Engineering
The University of Akron
Akron, Oh 44325

INTRODUCTION

Voice recognition through computing systems is the process by which specific human speech patterns, such as spoken words or phrases, are understood by a computer. Being one of the most natural and effective methods of human interaction, speech offers distinct advantages over the more conventional methods of computer interaction. It does not require the use of the arms and hands as does the operation of a keyboard. In this aspect, it is ideally suited for the cerebral palsy patient and the accessibility of the given system is increased. Since most of the cerebral palsy clients have no control of their voluntary muscles and in order to build a complete voice interaction computing system, a simplified card reader was designed to help sorting timecards in the database processing working environment. This will solidify the client's independent computer work station.

The device will be used by a cerebral palsy patient to transfer timecards, one at a time, for computer input purpose. It is not cost effective and is difficult to find a sorter developed for the commercial market which is directly suitable for the cerebral palsy patient.

SUMMARY OF IMPACT

A simplied card sorter (figure 1) was designed to help a cerebral palsy patient in the database processing working environment. Before the development of the card reader, the client depended solely on the disabled coordinator to turn each daily timecard to input information. This process not only ties up the coordinator's time, the goal for the client to input fifteen timecards in the period of one hour with one hundred percent accuracy was not achieved.

Because of the development of the voice recognition payroll management program, the card sorter unit and the client's substantial progress, United Cerebral Palsy Center has sent the Pay Period Summary to Automatic Data Processing to print out the checks for the employees of the center. The total process can be handled independently by the cerebral palsy patient.

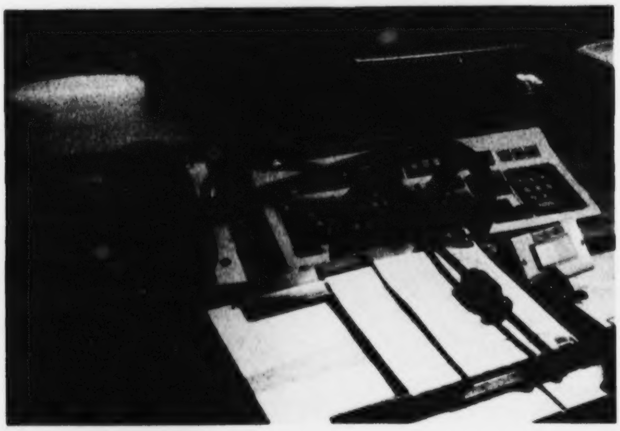


Figure 1: Simplified Card Sorter and Voice Recognition Unit

TECHNICAL DESCRIPTION

In order to build a card sorter, an aluminum tray apparatus where various sizes of timecards are transferred is first to be designed. The adjustable stone and urethane roller on the aluminum tray apparatus where the cards are transferred for reading purposes are the key devices that permit one card to be transferred at a time. A 1/10 horsepower, 60 rpm motor was used to drive the shaft of the card reader tray. For a 1/10, 60 rpm motor, the maximum torque of 8.75 ft-lb can be calculated from the equation:

$$T = 5252*hp/N$$

where, hp is the horsepower and N is the rpm. This satisfies the torque requirement since a 8.75 ft-lb torque will not be reached with this device. Also, it is necessary to use a low rpm motor so that timecards will be transferred slowly enough to be easily controlled by the client with a switch activating the mechanism.

Proper bushing, V-belt and pulley were selected to drive the shaft of the mechanism with the output shaft of the motor. The pulley and V-belt arrangement reduces the output speed of the 3/8 inch diameter shaft to about 20 rpm. Figure 2 shows the simple schematic of the entire mechanism when all put together. The aluminum tray is mounted on a wooden base, which is clamped to the patient's wheelchair. Also, the motor assembly is bolted to the computer table and remains stationary.

The entire sorter unit costs one-hundred twenty five dollars ($125) to build. The switch mechanism which starts the motor to drive the 5/8 inch diameter shaft is to be modified so that it can be activated by voice command.

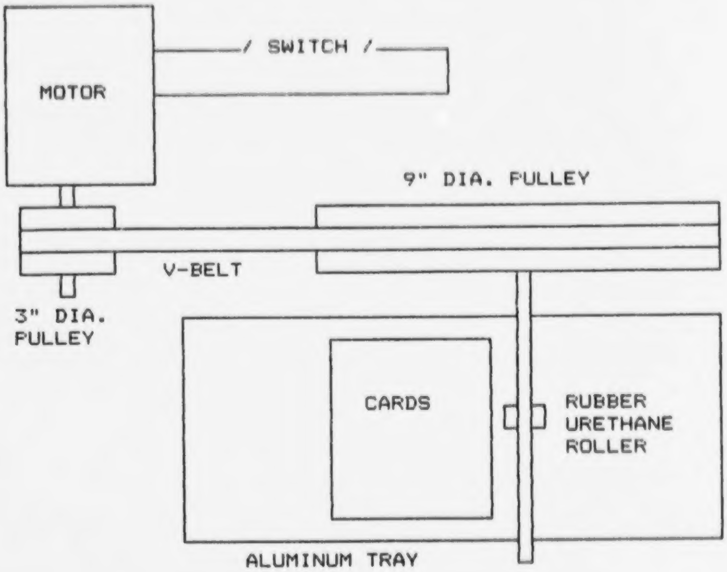


Figure 2: A schematic of the card sorter unit

"Silk Screen Fabric Stretcher"
An Adaptive Screen Printing Device for the Cerebral Palsy Patient

Designer: Mark Cressman
Disabled Coordinator: Norma Henson, United Cerebral Palsy and
Services for the Handicapped of Akron (UCPSH)
Supervising Professor: Dr. Paul Lam
Department of Mechanical Engineering
The University of Akron
Akron, Oh 44325

INTRODUCTION

Screen printing is a process during which ink is forced through screen mesh openings onto a transfer medium. The procedure is fairly simple and is used commercially for large runs of T-shirts, labels, cardboard notices, and political advertisements. It is also used in the area of printing electronic circuit boards. One of the major activities of UCPSH of Akron is to provide cerebral palsy patients with sub-contract works of silkscreening and printing. This type of activity helps the cerebral palsy patients to develop a positive self worth atitude which is just as important as developing their working skills. The major objective of this project is to design a fabric stretching machine used in screen printing. This machine is necessary for stretching various sizes of screen fabric over wooden frames to achieve drumlike tension, which is difficult to do by hand. The design is to be simple enough so that it is useable by cerebral palsy patients.

SUMMARY OF IMPACT

The UCPSH Center of Akron provides cerebral palsy patients with a variety of work programs to promote community awareness as well as developing independence for the handicapped. The printing of silkscreen T-shirts and labels are sub-contract works they received on a constant schedule. The fabric stretching machine (figure 1) was designed to improve productivity of the workshop.

Existing procedure requires that silk fabric be stretched by hand over a frame. This process is cumbersome and often leads to wrinkled fabric membrane. For some applications, synthetic fibers require a screen pressure of about 140 psi, which cannot be achieved by hand stretching. Also, stretching devices used by the UCPSH center consist of two separate frames, one was for the large screen printing and the other for the medium to small frames. The present fabric stretching machine design not only permits adjustable frame sizes, it provides an even fabric surface while simplifying the stretching method.

Early testing of the fabric stretching machine has proved that it is easy to use with good tension results. The design is simple but quite effective, and the hardware used is readily available should repairs be necessary. Many cerebral palsy patients have used this device with satisfactory results.

TECHNICAL DESCRIPTION

The basic design criteria for this fabric stretching machine is that the fabric is to be stretched with even tension without tearing the material, which often occurred with the previos design. The device is a four-piece stretching frame, made with thick member pine wood, into which the screen printing frame is placed.

In order to grip the screen fabric evenly and reduce its tendency to slip during tensioning, each stretching frame member contains a circular groove into which a quarter inch metal rod encased in rubber tubing is placed. This allows the fabric to be easily set in place with the fibers parallel to the frame. With the fabric in place, the rubber encased rod placed into the groove holds the material while being clamped. The rubber tubing accounts for any surface irregularities and creates a good friction surface to grab the fabric fiber. The clamping force is applied by using four bar linkage De-Sta-Co clamps that lock into position at adjustable settings. This makes for quick clamping without overtightening and damaging the wood.

To simplify the stretching process, two adjacent sides of the stretching frame are fixed and tensioning is accomplished by pulling the remaining free moving frame members. A free standing wooden table (figure 2) holds the fabric stretching machine was designed to be integrated as a work station.

For applying an even tension force along the moving frames, a steel cable is attached at both ends of the frame member with a pulley in between to self adjust so that equal tension is applied at each cable end. The cable is attached to a back plate of the frame with eyebolts. The tension force is transmitted through the threads of the bolt to the wooden frame by washers.

To pull the floating frames, the cable is attached to an angle iron that pivots about one end. By using the leverage of the bar, adequate force can easily be applied to tension the screen. A triangular block wedge is used to lock the stretcher while the material is being stapled. The wedges can also be tapped with a mallet to increase screen tension if pulling becomes too difficult. This design can stretch a screen for frames up to 28x28 inches, which is in the range of screens commonly used.

There are many fabric stretching machines available on the market. The most elaborate machine consists of a rigid inner frame and a floating outer frame between which a rubber bladder exists. The screen is fastened to the outer frame and air pressure put into the bladder causing the outer frame to expand, insuring even tension throughout the screen. The wooden frame is then placed underneath the stretched frame and stapled. However, the price of this machine is in excess of one-thousand five hundred dollars ($1,500). The entire unit of our stretching machine costs less than three-hundred dollars to build. Detail construction of the stretching machine can be obtained from the principal investigator.

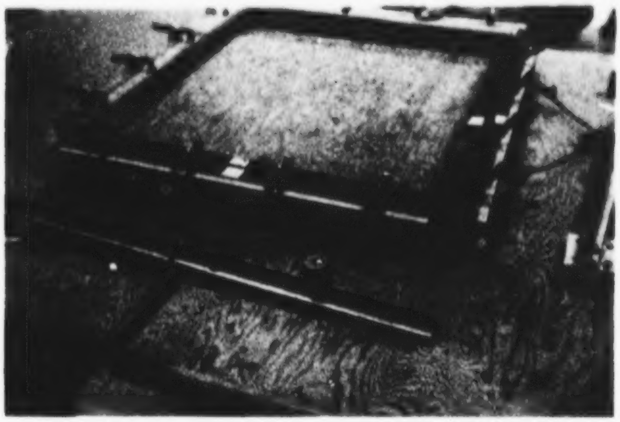


Figure 1: Fabric stretching device.

Figure 2: Screen printing work station.

"Mechanical Feeder"
Modifications of a Self Feeder Device for the Cerebral Palsy Patient

Designers: Robert Carver and Jean Costlow
Disabled Coordinator: Norma Henson, United Cerebral Palsy and
Services for the Handicapped of Akron (UCPSH)
Supervising Professor: Dr. Paul Lam
Department of Mechanical Engineering
The University of Akron
Akron, Oh 44325

INTRODUCTION

In this design, a mechanical feeder, owned by the UCPSH center, was to be modified to have an additional degree of motion. This additional degree of motion is to allow the spoon of the feeder to move forward towards the cerebral palsy patient after it had been raised from the plate with food. This modification is necessary since several of the user's had difficulty leaning forward and reaching the spoon at its original position. With this modification, the goal is to extend the use of the feeder to many other individuals who previously could not use it because they lacked the balance to lean forward and reach the spoon.

In the design of the feeder, several factors were taken into consideration. The first concern is that the control of the additional mechanism has to be simple to manipulate because the users are assumed to have less than average manual dexterity and muscle coordination. Another consideration is that the forward movement of the spoon had to be as smooth as possible. This requirement is necessary to insure that food will remain on the spoon as it moves toward the user. The final consideration is to maximize the forward distance travelled by the spoon.

SUMMARY OF IMPACT

The mechanical feeder shown on figure 1 is modified to included an additional degree of motion so that the spoon can move forward toward the user. The additional mechanism was easy to implement and is cost effective. Cerebral palsy patients, who previously cannot use the mechanical feeder, are able to operate this modified adaptive device. Also, several other patients are to be trained to use this mechanical feeder.

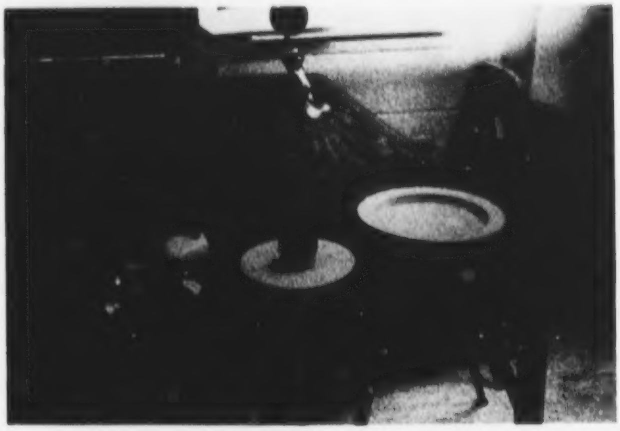


Figure 1: Modified mechanical feeder.

TECHNICAL DESCRIPTION

Initially, two basic designs were considered. The first of these modifications involved using a lever actuated rack and pinion configuration to move the spoon. This arrangement not only insures smooth forward motion of the spoon, it also allows the user to manipulate the feeder easily. One of the difficulties of this design is that the lack of space under the wooden base of the feeder will not permit a great deal of room for additional hardware to be installed without major modification. In addition, the plastic base of the spoon assembly must be reconstructed.

The second modification option involved attaching a handle assembly to the front of the plastic base of the spoon linkage, as well as mounting two pins to its bottom. A slot would then be cut through the wooden base of the feeder. These modifications would allow the spoon to move forward by pulling on the attached handle, being guided by the slot and pins. This design was selected as the mechanism to be added to the feeder because the component is very easy to implement and the user can control the feeder easily. Also, it was felt that any efforts required to overcome binding or friction problems were more than offset by the ease involved with the installation of the associated hardwares.

The conceptual drawing of the mechanical feeder is shown on figure 2. A 5.125 inch slot was first milled through the wooden base of the feeder. This slot was made so that it would be parallel to the direction of the spoon's motion. Two holes were then drilled and tapped into the plastic base of the spoon assembly. These holes were made so that they would line up with the slot in the wooden base of the feeder.

Two steel bushings, each having one flanged end, were inserted through the slot in the wooden base from the bottom. Bolts were then inserted through the bushings, and screwed into the holes made in the bottom of the spoon's assembly base. A sheet-metal bracket was next fabricated with a small wooden knob fastened to it. The bracket was mounted on the front of the spoon assembly base. This handle bracket provided a convenient way to move the spoon forward toward the user. With these modifications, it was found that the spoon could be moved forward slightly over three inches. Due to size limitations of the wooden base, this is the maximum distance which the spoon can travel.

Excluding machinist's time, the entire unit costs less than fifty dollars ($50) to build. Detail drawing of the modified mechanical feeder can be obtained from the principal investigator.

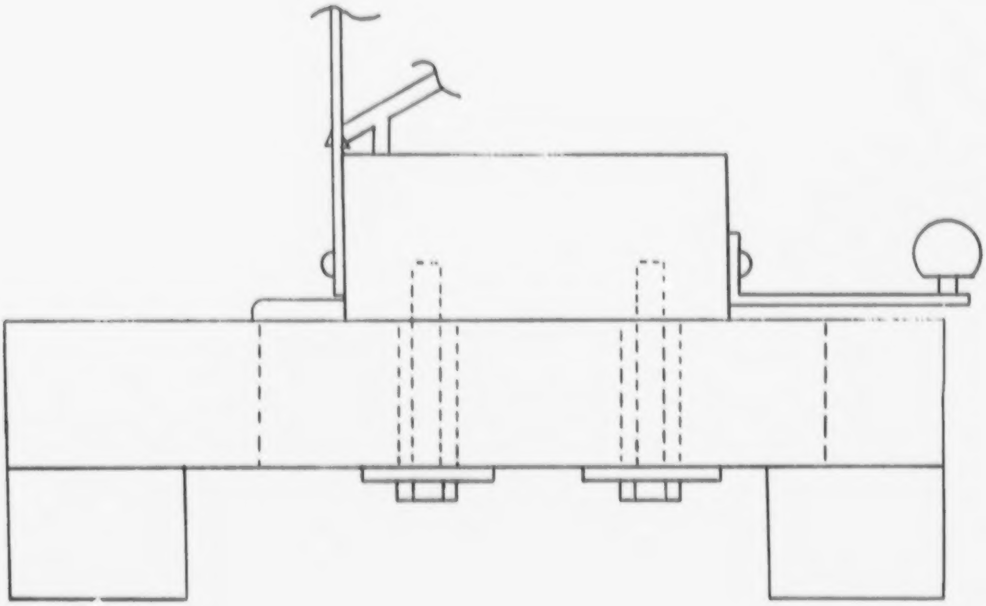
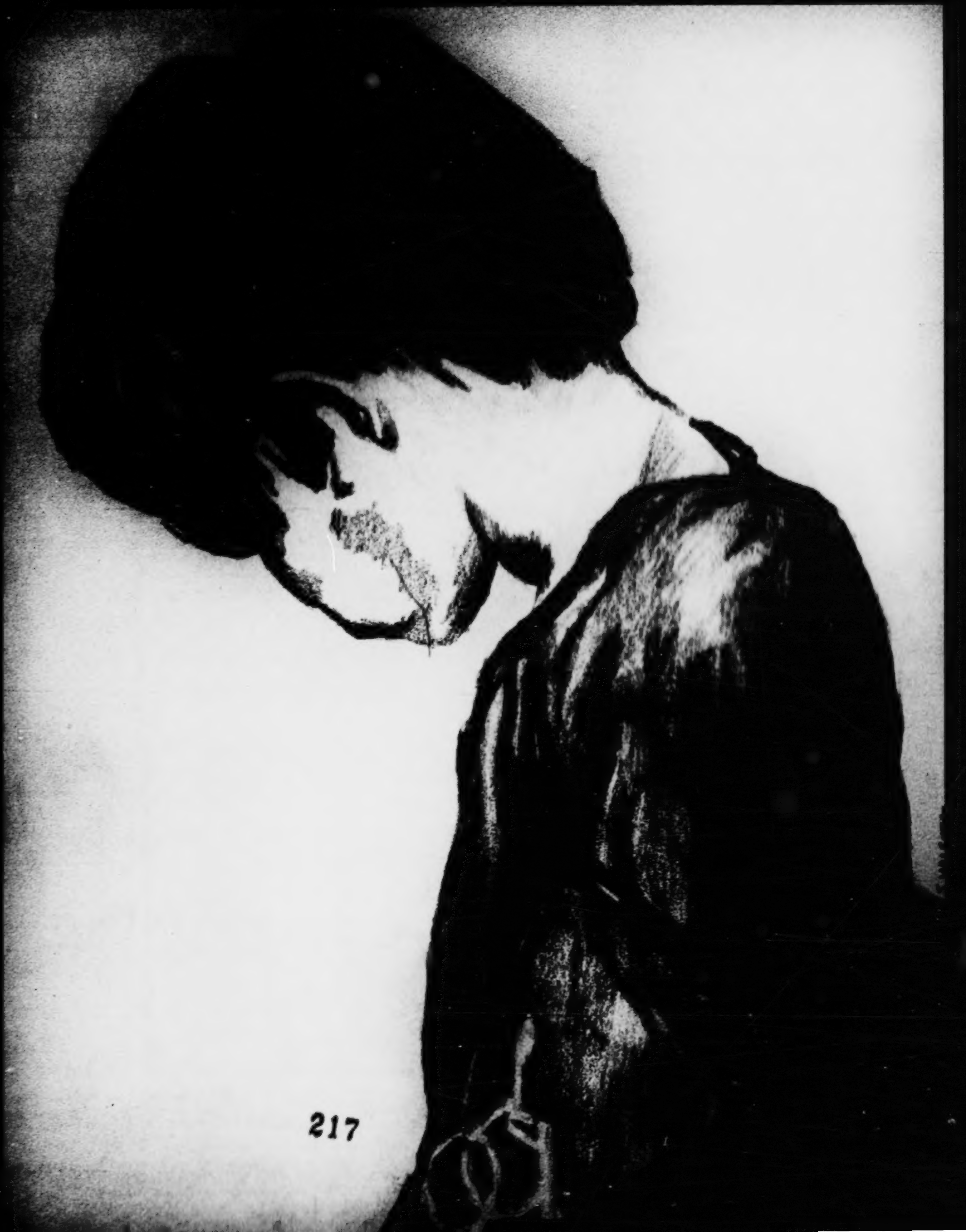


Figure 2: Conceptual drawing of the mechanical feeder.



CHAPTER 12

UNIVERSITY OF DELAWARE
COLLEGE OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING
NEWARK, DELAWARE 19716

Principal Investigator:

Robert H. Allen (302) 451-2421

A Critical Evaluation of a Birthing Model

Designer: Amy Louise Lerner
Disabled Coordinator: Freeman Miller, A.I DuPont Institute
Supervising Professor: Robert Allen
Department of Mechanical Engineering
University of Delaware
Newark, Delaware 19716

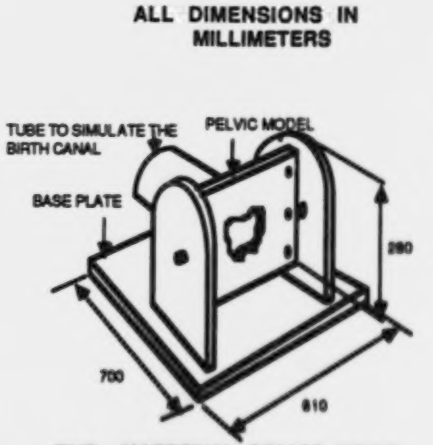
INTRODUCTION

A previously designed birthing model, as shown below, is a laboratory model for objectively evaluating portions of the human birth process. The model consists of an instrumented fetal model, an instrumented maternal model and an automated data acquisition system. The models are designed to measure stretching of the fetal neck and brachial plexus, twist of the fetal head and force applied to the maternal pelvis. In simulating births, engineering parameters can be measured to objectively evaluate injury-inducing mechanisms.

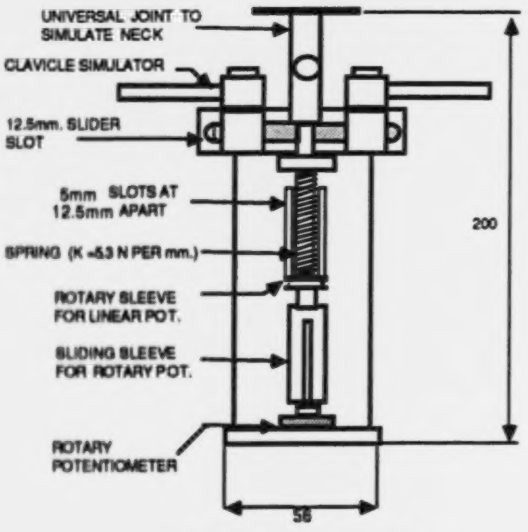
In this study, each component of the system was evaluated and a complete recalibration was performed on the fetal model. Several mechanical problems and solutions were identified and geometric modeling of the anatomy was suggested.

SUMMARY OF IMPACT

A birthing simulator has been evaluted to determine the efficacy of the original design. With an effective birthing simulator, obstetric clinicians can be trained in the engineering aspects of childbirth and, as a result, be aware of the cause, and avoidance, of iatrogenic birth injuries. Some difficult births, called shoulder dystocia, result in fractured clavicle, neck nerve damage and even death because too much force is used to deliver the newborns. With an improved simulator, we can control some of the parameters associated with difficult delivery and monitor them in a laboratory setting. By establishing force thresholds for potential injury, clinicians can be trained to recognize this force level and learn to deal more effectively with this obstetric emergency.


ALL DIMENSIONS IN MILLIMETERS
TUBE TO SIMULATE THE BIRTH CANAL
PELVIC MODEL
BASE PLATE
280
700
810

THE MATERNAL PELVIC MODEL


UNIVERSAL JOINT TO SIMULATE NECK
CLAVICLE SIMULATOR
12.5mm. SLIDER SLOT
5mm SLOTS AT 12.5mm APART
SPRING (K =5.3 N PER mm.)
ROTARY SLEEVE FOR LINEAR POT.
SLIDING SLEEVE FOR ROTARY POT.
ROTARY POTENTIOMETER
200
56

MECHANICAL FETAL MODEL

TECHNICAL DESCRIPTION

The existing fetal model is designed to simulate the parts of the fetus involved in shoulder dystocia.[1] Primary areas of injury are the neck, clavicle, and brachial plexus. Therefore, the model is instrumented to measure the forces applied to the neck, and the extension of the brachial plexus. The external shape of the model was defined by a latex mannequin and plastic skull used in obstetric training. The model was covered with a velvet cloth simulating frictional characteristics of the fetus.

The neck of the fetus is flaccid, and can stretch, flex and twist easily. In the existing model, the neck is simulated by a universal joint between the skull model and a shaft. Tension on the neck compresses a spring to simulate the extension of the fetal neck. This extension is monitored by a linear potentiometer. The neck shaft also transmits twisting of the neck to a rotary potentiometer.

The clavicle is represented by a wooden dowel simulating the forward, hunched position of fetal shoulders during delivery. The model allows adjustment of the biclavicular diameter by moving the attachment blocks for the dowels. This allows an evaluation of the effect of infant size on management of shoulder dystocia.

The brachial plexus is composed of nerves which emanate from the vertebrae of the neck. These nerves join together and pass beneath the clavicle before forming cords and then branching to supply the arm. The brachial plexus may be stretched by tension on the neck, and lateral flexion or twist of the neck. In the model, the brachial plexus is simulated by a string attached to the base of the skull and extending down the torso of the model to a potentiometer that detects extension.

The maternal model consists of a wooden plate with a carved opening simulating the pelvic opening. This plate is attached to two side plates which allow variation of the angle of the pelvic opening, since maternal positioning is a key management technique for shoulder dystocia. The model also included thin film piezoelectric sensors to detect forces transmitted to the pelvis during delivery. The uterus is simulated by a hollow cylinder which is attached with a hinge to the pelvic plate.

The above components interfaced with an IBM PCAT to collect data during laboratory or clinical testing. The system used a DT 2808 A/D converter to read voltages from the piezoelectric sensors and potentiometers. The software PCLab included subroutines linked to programs written in BASIC by the user to control data acquisition.

RECOMMENDATIONS FOR AN IMPROVED MODEL

Based on the calibration process, several areas were identified in which improvements could be made to the fetal model. In general these were mechanical problems rather than problems with the measurement system per se.

- *Brachial Plexus Simulation* - The fetal model doesn't accurately simulate the location of the brachial plexus in the human fetus. In the current position, parallel to the neck shaft, the effects of neck flexion, twist and bending of the clavicle are quite different from effects actually present in the human fetus. While it is true that the model gives a good indication of the degree of each manipulation, it is not clear that any prediction of actual injury risk can be made. In addition, the material chosen for the simulator effects extension detected by the potentiometer.

- *Twist Measurement* - Considerable play was found in twist sensor motion. A very close pin fit and reduced size of the keyway would limit this play. Also, due to orientation of the potentiometer, a counterclockwise twist of the head greater than 60° results in a false reading. A full 180° of motion is available, however, the potentiometer or keyway would have to be repositioned. The head should be mechanically prevented from twisting into the false reading regions of the sensor.

- *Neck Spring Constant* - The spring constant in the neck of the fetal model was not found to correspond to the value documented in previous reports. The nature of the extension of the fetal neck should be determined and a spring obtained to simulate it.

- *Fore/Aft Flexion Calibration* - In the current evaluation, the effect of fore/aft flexion of the head on brachial plexus extension was not calibrated. Large amounts of forward flexion do appear to cause a significant amount of extension, and for completeness, this calibration should also be included in the process.

- *Superposition* - The current calibration was made assuming that the individual effects of flexion, twist and extension of the neck could be superimposed to determine the total effect on brachial plexus extension. While this is a good approximation for small angles, it appears less valid at the extremes of the range. The significance of this error should be determined, mathematically or by actual measurement of combined manipulations of the fetal model.

1. Sorab, J., "Design and Development of Engineering Aids to Evaluate the Birthing Process," MS Thesis, University of Houston, May 1988

An Improved Baby Crib

Designers: Joseph Budd, John Homlish, Dennis Neaves
Disabled Coordinator: Barry Seidel, University of Delaware
Supervising Professors: Robert Allen, Ralph Cope
Department of Mechanical Engineering
University of Delaware
Newark, Delaware 19716

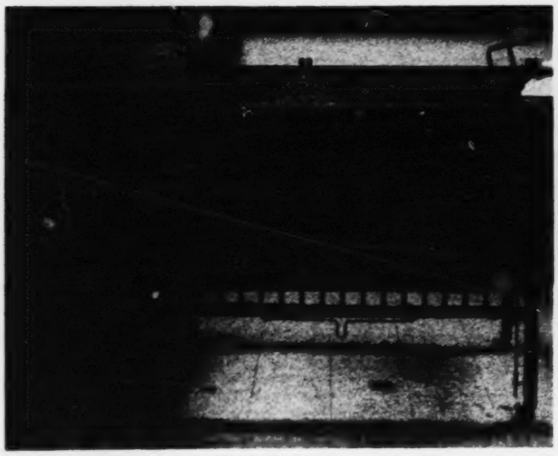
INTRODUCTION

Commercial baby cribs can be improved in two identifiable ways. One such improvement is to raise the mattress, and hence the infant, closer to the normal reach of a typical adult when removal from the crib is imminent. A second improvement is to reduce the amount of time, or effort, it takes to assemble and disassemble a crib.

A variant design on a conventional crib, which is shown in the photographs below, incorporates these features; namely, when a side of the crib is lowered, the mattress is raised via a hidden pulley mechanism. This raises the mattress closer to the natural placing height of a typical adult. In addition, modular construction of the crib makes it possible for one individual to assemble the crib easily in about 12 minutes.

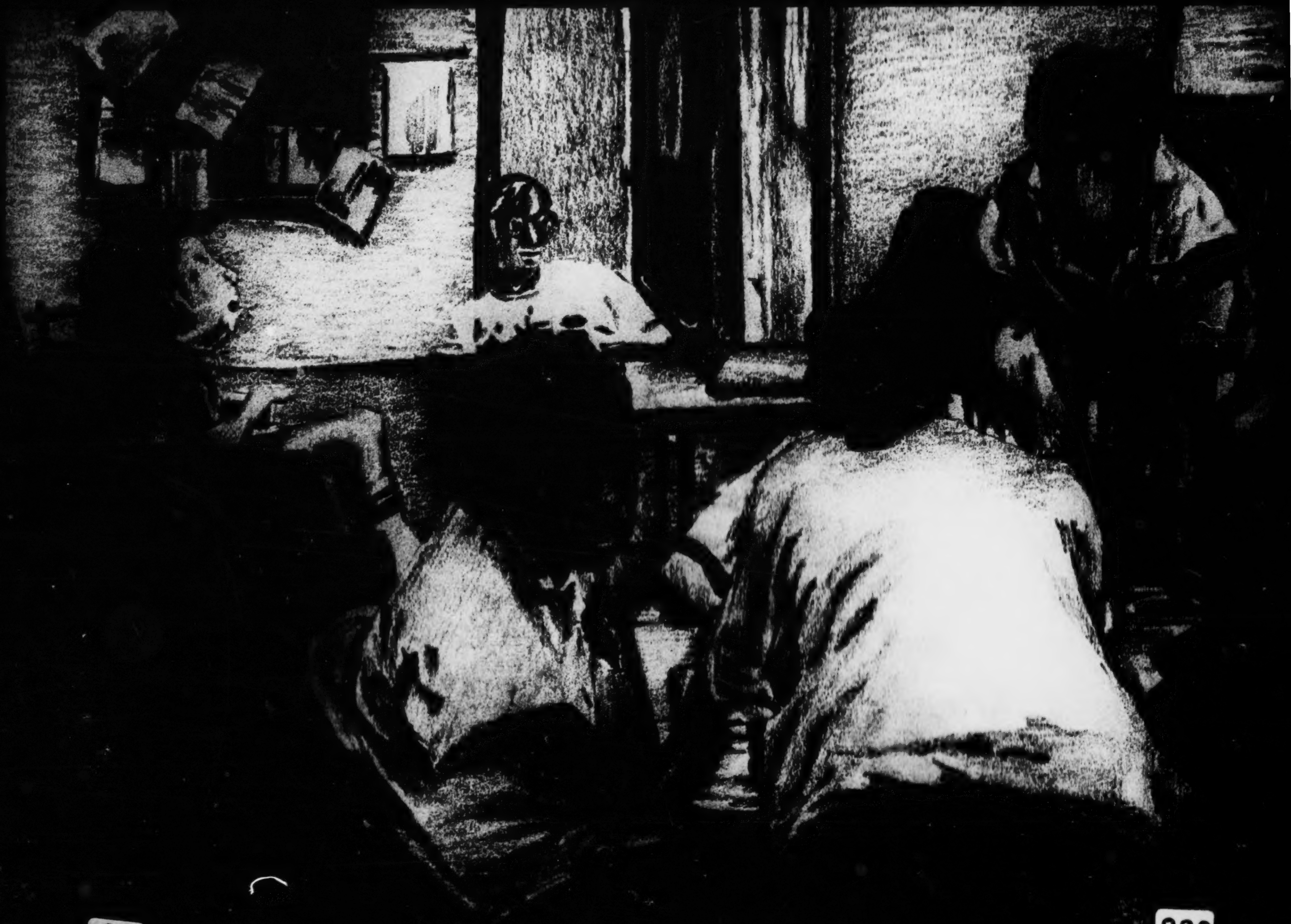
SUMMARY OF IMPACT

A baby crib has been designed to automatically raise the height of the mattress support when a side is lowered. With such a baby crib, parents and other caretakers can pick up a baby without having to bend over as much as with a conventional crib. With this modification, it is expected to reduce the amount of stress on the adult back. For individuals with back injuries and wheelchair-bound parents, it is easier to pick up and place babies in cribs. In addition, the crib was designed to ease the assembly process. By using modular construction, the crib is also easier to assemble than many conventional cribs. By slightly modifying conventional crib design, it is hoped that picking, placing and assembly are made easier for parents.



Crib, with rail up and mattress support "down."

Crib, with rail down and mattress support "up."



CHAPTER 13

UNIVERSITY OF DELAWARE
COLLEGE OF ARTS AND SCIENCES
DEPARTMENT OF COMPUTER AND INFORMATION SCIENCES
NEWARK, DE 19716

Principal Investigator:
Dr. Richard A. Foulds (302)651-6830

The Design and Development of a Usage Tracking and Analysis Facility for an Augmentative Communication System

Designer: Robert A. Elkins
Disabled Coordinator: Patrick W. Demasco
Applied Science and Engineering Laboratories
A.I. duPont Institute, Wilmington, DE
Supervising Professor: Dr. Kathleen McCoy
Department of Computer and Information Sciences
University of Delaware
Newark, DE 19716

INTRODUCTION

Many communication systems allow for flexible configuration of the vocabulary set by the clinician. Generally, selection and positioning of lexical units within the vocabulary set is done by the clinician through consultation with the patient and through his or her own common sense choices. However, since the clinician has a limited number of sessions with the patient, rarely is a vocabulary set chosen from scratch. Usually, the clinician augments the vocabulary set supplied with the communication system with additional words and phrases. Two problems exist with this method.

The first problem is that of vocabulary choice. Initial selection of lexical items could preclude inclusion of a frequently used word, causing the patient to have to repeatedly form it from its letters, significantly decreasing his or her communication rate. A less serious, but related problem is the inclusion of a word that is rarely used. A large number of superfluous words contributes to an increased search and selection time for the patient and, consequently, a decreased communication rate.

The other problem is that of search and selection time for a lexical item. In a communication system, items that are used more frequently should be placed where they can be selected quickly. If a frequently selected item is inconveniently positioned, this results in an increased search time.

A facility that monitors real-time patient usage of the device and provides a detailed report of selection behavior would aid the clinician in choosing an appropriate vocabulary set and better placement of lexical units for their patient's communication needs.

TECHNICAL DESCRIPTION

The system was developed as an extension to the Meta-4 communication system1. Meta-4 is a communication system being developed at the Applied Science and Engineering Laboratories of the University of Delaware and A.I. duPont Institute. Currently in beta-test stage, Meta-4 is designed to be used on a portable IBM-PC compatible computer. The overall philosophy of the system is to be as flexible as possible. Currently, Meta-4 supports several input strategies and devices as well as fully user configurable vocabulary and page layout. The tracking and analysis system consists of two logical components, an interface to the run-time of the communication system known as the tracker and a separate software system for analyzing the usage data produced by the run-time interface known as the usage analyzer.

The methodology of the system is as follows: The communication system is used by the patient in a normal manner. While the communication system is being used, the run-time interface records the patient's selections and the elapsed time between selections in a file. This file is referred to as the history file. The history file is used as input to the analysis system. The analysis system uses the data from the history file along with additional files which define the vocabulary set of the device, to produce a detailed report summarizing the patient's communication activity.

Tracker

The tracker was implemented as an event called from the main loop of the Meta-4 runtime. The tracker's first task is to open the current day's history file and initialize the record for the current session. Once the session record is initialized, the tracker is called after each selection the user makes. A timer is maintained, and it measures the elapsed time between selections in one-hundredths of a second. Each selection is recorded in the data-file along with the elapsed time taken to make the selection. The tracker maintains a buffer of the three most current selections, and the file is updated when either the buffer fills up, or ten minutes elapses between selections.

Usage Analyzer

The usage analyzer was implemented as a batch-orientated facility which is run after the Meta-4 session(s) are completed. The analyzer uses the history files created by the tracker and Meta-4's vocabulary files as input and generates output in a format compatible with *Borland Sprint*, a text processing and formatting package which uses a *Scribe*-like command set.

Initialization

When initialized, the analyzer first loads in all of the data files that specify Meta-4's current vocabulary set. This vocabulary set is known as the book. The book is organized into separate pages, with each page being a separate data-file in the book directory. The items in the page files are loaded into a database which is implemented as a hash-table. The hash-table is implemented as a linear array of buckets with chained slots. A simple hashing algorithm is used, where the hash value is computed from the modulus of the sum of the ASCII values of the characters in the hash key by the number of buckets in the hash-table. The hash-key is formed from the concatenation of the literal and function-list fields of the item and the current page name. The concatenation of these three fields results in a unique identifier for each item. As the items are loaded in, a separate record in the hash-table is created for each item.

Analysis

Once the book is loaded into the database, the history files are opened and read in item by item. Each item is found in the hash table from the hash-key which is the same as the first field in the item record. Once the item is referenced, the selection counter, times list and total-ticks fields are updated. In addition, the function-list field is parsed, and if the function changes the state of the current page, the current page global variable is updated accordingly. This variable is used in constructing the hash-key for each item in the history file. In addition, a buffer is maintained for the construction of new lexemes. Any group of letters deliminated by a space, punctuation, an existing word, or a page-change command is considered by the word-builder function as a word. Once a word is recognized, its existence as a new item is checked in the hash-table. If it is found, its state variables are updated, otherwise it is added to the table. This process is repeated until all the history files are read.

Sorting

Once the analysis is complete, the entire contents of the hash-table are copied into a dynamically allocated linear array. The array is then sorted, using the quicksort algorithm. The elements are sorted into non-decreasing lexical order on two keys; the primary key is the page name and the secondary key is the literal field of the item. The quicksort algorithm is extremely efficient, and is able to sort the array with an average case time complexity of $O(N\ Log_2\ N)$.

Report Generation

The sorted linear array is then passed to the reporting function which generates the output. For each item, the following pieces of information are printed in a table like format:

1. Frequency of occurrence
2. Average selection time
3. Selection rate
4. Literal Field
5. Function List
6. Location in the vocabulary set

The final output of the analysis facility is a text file which can be interpreted by the *Borland Sprint* typesetting package. The prototype's output was designed to be printed in landscape format on a PostScript compatible printer.

References

1. Demasco, et al., "The Implementation of a Software Methodology for Communication Aids," RESNA Proceedings, 1987, pp. 745-747.

High Stability Walker for Child Patients with Cerebral Palsy

Designers: Robert Black III, James DiMaggio, Ann Marie Sastry,
Jay Thomas
Disabled Coordinator: Dr. Freeman Miller,
Department of Orthopaedics, A.I. duPont Institute
Wilmington, DE 19899
Supervising Professor: Dr. Ralph D. Cope
Department of Mechanical Engineering
University of Delaware
Newark, DE 19716

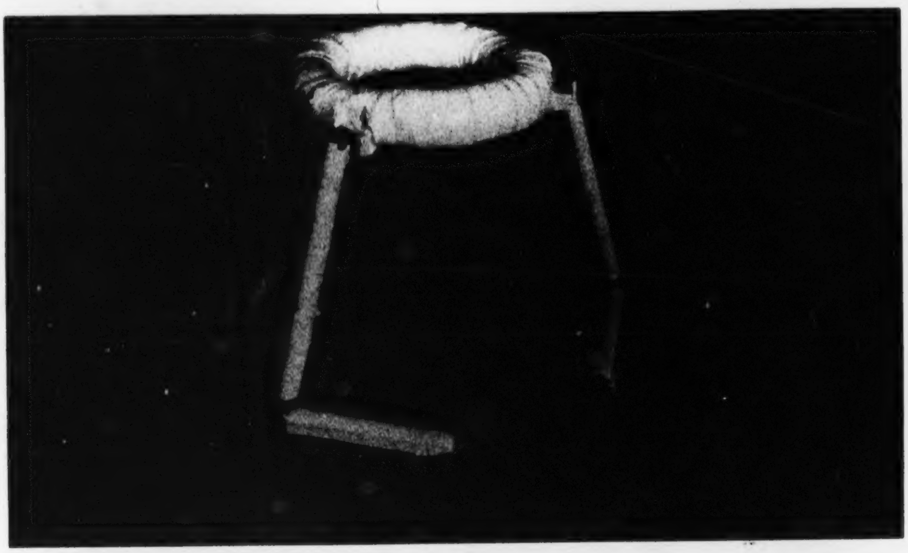
INTRODUCTION

The high stability walker is a wheeled device which both supports the cerebral palsy patient and allows for mobility while providing high stability. The patient sits on a bicycle type seat which is suspended from a swivel ring which is in turn supported by vertical members that attach to the wheeled base. All wheels are castered and the device is easily moved by the patient "walking" along the floor. The swivel ring allows the seat to rotate about a vertical axis so that motion in any direction is simplified. The wide base provides for high stability. In addition, telescoping members in the base ring allow the ring to partially collapse to pass through typical doorway.

Removal of four bolts allows the entire device to be packed flat for ease in transportation. All frame members are padded to minimize patient injury.

SUMMARY OF IMPACT

The primary goal of the device is to provide a highly stable unit which allows the patient to propel himself with few limitations to overall mobility. The wide base makes tipping nearly impossible while the collapsing design limits restrictions to mobility. Patient support is accomplished through the use of the suspended seat and also by the enclosing swivel ring. Patient placement into the unit is somewhat difficult; however, once in place the patient is quite secure. Padding of all members reduces the possibility of patient injury from contact with frame members.



TECHNICAL DESCRIPTION

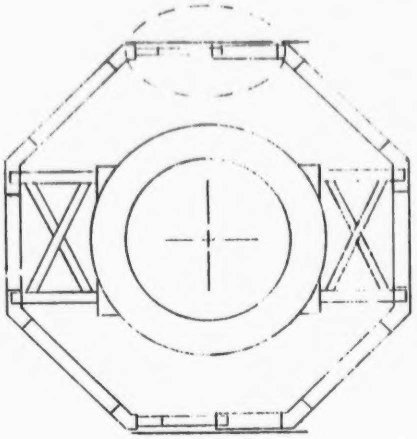
Critical design constraints for this prototype were: stability, maneuverability and comfort. In addition, it was necessary that the unit be relatively easily transported and that it not be cost prohibitive. Several design concepts were developed and analyzed before the given design was chosen.

As shown in the top view and the photograph, the walker consists of two rings separated by two side braces. The top ring has an inside diameter of fourteen inches; and, supports the seat and allows it to pivot about a vertical axis. The cross-section of the ring member is basically a box with a through slot through the middle of the bottom surface. On the interior of the box is a second ring, concentric to the first, which is connected to several wheels which ride on the inside of the bottom surface of the box section. The seat is supported from this second ring at three places. This arrangement allows the seat to rotate freely yet keeps the relative positions of the seat straps fixed so that the seat does not tip. To the outside of the box section are affixed four limited motion pivot blocks. These allow the angle between the plane of the side braces and the swivel ring to change when the base is collapsed for passage through doorways. Motion at these hinges is limited to reduce tipping of the swivel ring. For the prototype, the swivel ring was constructed of wood but testing revealed that future designs require a stronger material at the hinge points.

Each side member is constructed of two vertical members rigidly connected by an X-brace. The parallel, vertical members are twenty-four inches long and are separated by twelve inches. To reduce weight, the vertical pieces were constructed of pultruded one inch square, fiberglass box beams while the X-braces were 1" x 0.1" fiberglass bar stock.

The base ring is octagonal with each side having a nominal length of fourteen inches. Inch and one-half square, pultruded fiberglass, box beams were used for each side with aluminum inserts for each joint. The front and rear sections of the octagon were made using common drawer slides which were adjusted to allow a maximum side length of fourteen inches yet permit the octagon to collapse to a maximum width of twenty-eight inches. Limited motion hinges were again used to connect the side supports to the base ring. Six inch diameter hard rubber casters were attached at each apex of the octagon.

The total price for the construction of the walker prototype, excluding labor and design costs, was $300.



Motorized Mobility Device for Handicapped Children

Designers: Kathleen Beutler, Alicia Fenton,
Scott McClintock, Flip Britton
Disabled Coordinator: Carol A. Sargent
Supervising Professor: Dr. Ralph D. Cope
Department of Mechanical Engineering
University of Delaware
Newark, DE 19716

INTRODUCTION

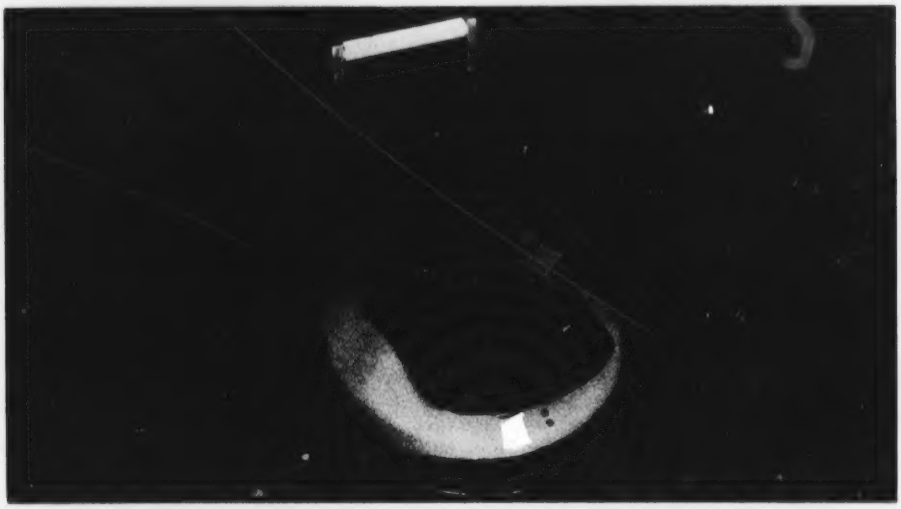
The motorized mobility device is a saucer like, electrically powered, "wheelchair" designed for use by small children. It is principally targeted for children between the ages of 1 and 3. The device is powered by two, rechargeable, gel-cell batteries which drive two independent motors connected directly to the drive wheels. Directional control is done via a joystick which activates a proportional controller similar to that used on electric wheelchairs for adults. The joystick can be replaced by other switching devices appropriate to a particular child's handicap. The child rides atop the saucer in a modular seat which can be easily altered to suit the needs of the individual.

The device will be used by therapists as a means of evaluating certain motor skills which aid in the transition to typical wheelchairs. The design is also usable within the household environment to maximize the mobility of a handicapped child.

SUMMARY OF IMPACT

The motorized mobility device was designed to aid therapists in evaluating the motor skills of handicapped children and to provide a "child size" device to increase their mobility. For evaluation purposes, the controls and seating are modular. As such, they can easily be removed, altered and replaced. This provides an easy method for judging the ability of a child to adapt to other mobility devices.

From a mobility aspect, the device is designed to place the seated child at eye-level with his or her peers. The conventional drive mechanism coupled with the round body style promotes maneuverability and handling. Further, the device is low to the ground allowing for the possibility of mounting from the floor by a child with good upper extremity function and mobility. As such, the unit gives the child the ability to freely interact with peers. Maximum speed of the unit can be set by adult and a tethered control box can be used to override the child's input.



TECHNICAL DESCRIPTION

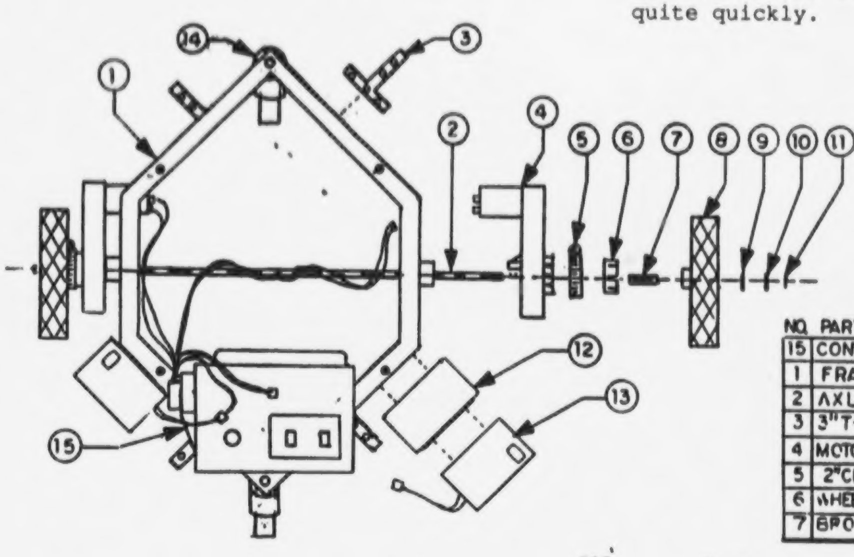
The design of the mobility device can be divided into three principal areas: the frame and drivetrain, the electronics, and the body and seating. The frame provides the base upon which all other systems are attached. As shown in the figure, it is a welded, hexagonal structure made from one inch square, one-eighth inch wall aluminum tubing. The frame measures twenty-four inches from front to back and sixteen inches from side to side. Four eight inch long, one half inch diameter aluminum rods are welded normal to the frame (these are shown as black dots on the angled sides of the frame) and extend vertically through the body to support the seat. The axle is made of seven-sixteenths drill rod and extends through the frame. It does not rotate but merely supports the wheels. Also attached to the frame are four T-plates to which the body is bolted, and two pans to which the batteries are strapped in place. The drive for the wheels is provided by two gearmotors used on the "Quadrunner" car built by Powerwheels. These units weigh approximately one half pound each, include a 110 to 1 gear reduction, will run under variable voltage control and can be bought off-the-shelf. The gearmotors are affixed directly to the frame and a special hub was constructed to mate the gearbox output to the wheels. The wheels are seven inch diameter hard rubber wheels with bushings inserted to minimize wear.

The electronics system is based on an ABEC proportional controller. The controller was modified to provide for a remote location of the joystick and on/off power switch. The centering springs in the joystick were also replaced to correspond with a child's strength. Power for the controller is provided by two six-volt gel cell batteries wired in series. On a full charge, the batteries can operate the unit for approximately three ours. The battery charger was not mounted on the unit.

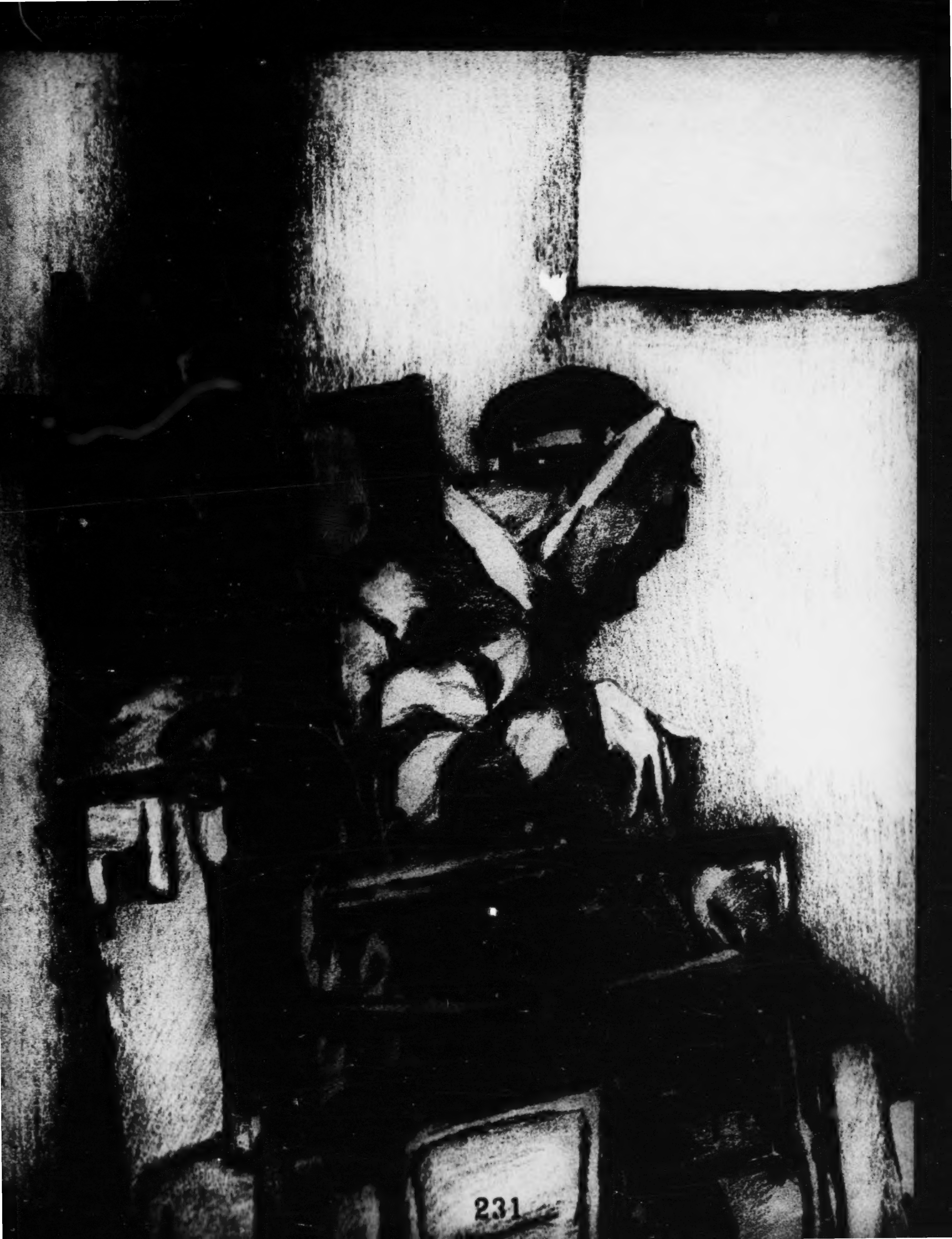
The body of the unit was constructed of kevlar cloth and polyester resin which was fabricated over a male mold. The diameter of the shell is twenty-eight inches and it is eight inches deep. L-brackets, which attach to the T-plates on the frame, are affixed to the inside surface with through bolts. A bucket type recess was placed in the top of the body to provide for a child with tetraphocomelia. An access door in the front of the shell allows access to the controller and the on/off switch was placed on the back of the shell out of the child's reach. For demonstration purposes, an aluminum frame seat was constructed which attached directly to the seat support posts. A foam "bumper" was placed around the entire shell to reduce collision damage.

The prototype of the motorized mobility device cost a total of three hundred sixty ($360) dollars to construct. This price did not include the cost of the proportional controller which was provided by the A.I. duPont Institute.

Initial testing of the unit was done with 2- to 3-year-old non-handicapped children. All children seemed to enjoy the device and adapted to the controller quite quickly.



NO.	PART	REQ'D			
15	CONTROLLER	1			
1	FRAME	1	8	7" WHEEL	2
2	AXLE	1	9	NYLON WASHER	2
3	3" T-PLATE	4	10	STEEL WASHER	2
4	MOTOR/GEARBOX	2	11	7/16" SNAP RING	2
5	2" CLAMP	2	12	BATTERY TRAY	2
6	WHEEL-HUB	2	13	6-V BATTERY	2
7	BRONZE BUSH'G	2	14	3" CASTER	2



CHAPTER 14

UNIVERSITY OF FLORIDA
COLLEGE OF ENGINEERING
DEPARTMENT OF AEROSPACE ENGINEERING, MECHANICS, AND ENGINEERING SCIENCE
GAINESVILLE, FLORIDA 32611

Principal Investigator:

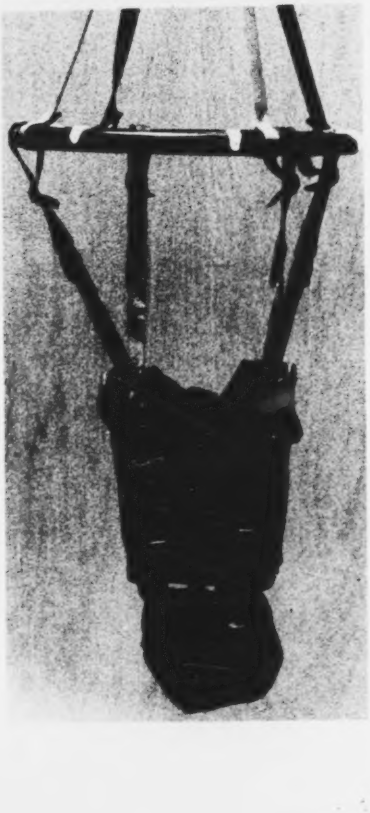
Robert J. Hirko (904) 392-0961

Adaptive Trunk Support Harness for a Congenital Cerebral Palsy Patient

Designers: Drew Amery, Ken Anderson, Stephanie Riley
Disabled Coordinator: Claudia Senesac, P.T., Kids On The Move
Supervising Professor: Dr. Robert J. Hirko
Aerospace Engineering, Mechanics, and Engineering Sciences
University of Florida
Gainesville, FL 32611

INTRODUCTION

An Adaptive Trunk Support Harness was necessary to offer a young child with cerebral palsy proper support while being held in a seated position on the ground under a special portable frame. This harness permits trunk support to be adjusted over a wide range by the adjustment of the angle of support straps and the attachment points of the straps on the harness itself. A spreader assembly above the harness facilitates this angle adjustment. These adjustments were intended to make the patient work to his limit and facilitate development.



SUMMARY OF IMPACT

The Portable Support Frame and Support Harness for a Congenital Cerebral Palsy Patient were designed to facilitate independent sitting and use of the upper extremeties (UE's). The child is hypotonic with cerebral palsy. He is unable to sit independently, has poor head and trunk control, limited mobility and use of his UE's. It is extremely difficult for this child to attain an erect head and trunk position and then be able to use his UE's independently to explore toys, play and interact with his peers and environment. These activities are so basic to learning about our world and ourselves. Learning is a sensory-motor experience.

The Support Harness gives the child trunk support, pelvic stability (through the seat cushion and length of the suspension straps) and the opportunity to use the UE's as described above. The device offers variability in the amount of support given to the trunk and the amount of excursion anterior/posterior and lateral with diagonal movements available. Through proper positioning, strengthening of neck and trunk musculature is possible. With the adjustments as mentioned it is possible to increase the range the child can safely perform in independently.

TECHNICAL DESCRIPTION

This trunk support harness was designed to support a two year old who weighed 25 pounds. It was intended to be adaptable to the child in fit and function in as many ways as could be incorporated. These included first adjustability of the vest and shorts for fit as he grew. Next, a method for adjusting support constraints to permit control over the demands put on the child's own musculature was developed and included. Means for adjusting the support height was also necessary to adjust the vertical support position with respect to the play surface.

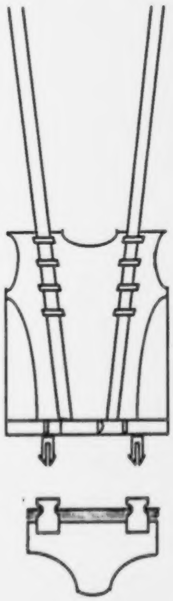
The harness is illustrated in the figures below. It consists of three functional pieces: shorts, vest, and support ring. The shorts and vest are made from denim fabric which provides a reasonably lightweight but strong support. Both the shorts and the vest are split on both sides and possess velcro closures which make dressing the child an easy task. A wide range of adjustment to the child's size is also made possible by the design of these closures.

Straps which function to both lift the user a small amount and restrict forward-backward and side-to-side motion are attached to the shorts and the support ring above, but removable at both ends. These straps are made of a 3/4" tubular nylon strapping material commonly used in camping or climbing gear. It is much stronger than necessary for the application but is softer and more pliable than comparable flat strapping. Each strap may be attached to one of three locations on the support ring above the user's head. The point of attachment is related to the angle of the straps for each particular amount of support to be given.

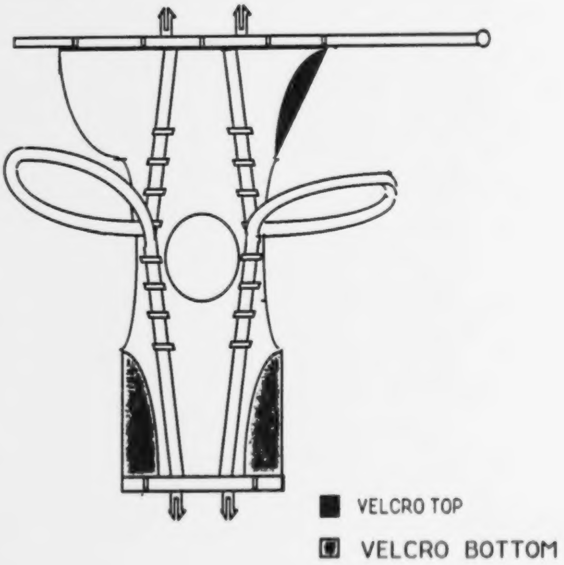
Between the shorts and the support ring above, the straps run along the front and back of the vest passing through various guideloops. These guideloops determine the point of withdrawal of the support along the upper trunk of the body. Initially the uppermost loops are used. The child has very little trunk and neck control, therefore with the support at the top of the shoulders he will not need to work the trunk muscles very much. This will permit the concentration on development of the neck for strength and control.

As he develops the straps may be taken out of the top loops to move the point of support downward along the trunk. This will permit more freedom of movement and demand more development of strength and control. Eventually it is expected that support straps will be passed only through the bottom loop in the vest thus giving maximum freedom and demanding maximum self sufficiency on the child's part.

Cost of materials for this harness was $80.44.



Front view of harness



Expanded chest harness

Portable Support Frame for a Congenital Cerebral Palsy Patient

Designers: Ivan Howard, James Larson, Herb Sivitz, Hai Vu
Disabled Coordinator: Claudia Senesac, P.T., Kids On The Move
Supervising Professor: Dr. Robert J. Hirko
Aerospace Engineering, Mechanics, and Engineering Sciences
University of Florida
Gainesville, FL 32611

INTRODUCTION

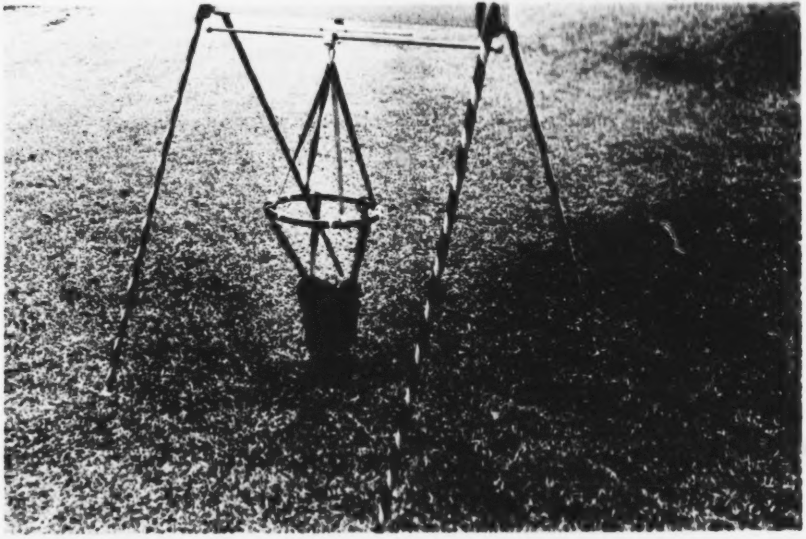
The Portable Support Frame was designed to offer a circular space on the ground in which this child is safely supported but still has some freedom to move and explore his toys and the environment. The frame was designed to supply the support over this circular range of motion while being light and easily "broken down" for transport. It is also brightly colored to appear like a toy to the child and be as unobtrusive as possible in his environment.

The parents of this child wanted a support that could be used as easily in the house as it could in the back yard or playground. Component parts of the frame disassemble and pack in a carrying case for ease of transport. The device has also been used in sessions with the child's therepist.

SUMMARY OF IMPACT

The Portable Support Frame and Support Harness for a Congenital Cerebral Palsy Patient were designed to facilitate independent sitting and use of the upper extremeties (UE's). The child is hypotonic with cerebral palsy. He is unable to sit independently, has poor head and trunk control, limited mobility and use of his UE's. It is extremely difficult for this child to attain an erect head and trunk position and then be able to use his UE's independently to explore toys, play and interact with his peers and environment. These activities are so basic to learning about our world and ourselves. Learning is a sensory-motor experience.

The Portable Support Frame permits the child to be supported seated on the ground in a special harness anywhere within a fixed radius from the center of the frame. As the child gains strength and control he may move at will within that circle as he explores his world and interacts with others all the while benefitting from the support afforded by the frame-harness system.



TECHNICAL DESCRIPTION

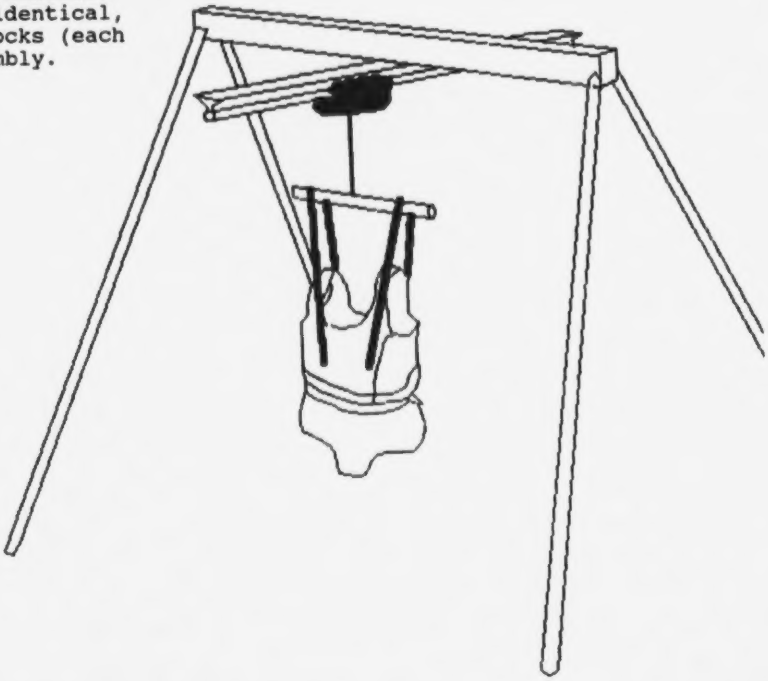
Design of this portable support structure was done under the following constraints. The structure must be self-supporting through normal and routine usage. Its static load capacity must possess an adequate safety margin to handle possible impulse loading, due to bumping, etc., without serious structural instabilities which could injure the user. The structure should be as light as possible for ease of carrying. It should be collapsible into as small a volume as practical. Ease of assembly and disassembly should be high. When assembled it should yield a large area of support for the child underneath.

The support is shown in the picture on the previous page. The frame consists of an aluminum 1.75"x3" box beam approximately 4.5 feet in length supported by four removable legs. The legs are constructed out of 1" diameter aluminum tubing. These legs are connected on their bottoms by small vinyl covered cables (like fishing line leader) for stability and to minimize the bending moments generated in them. Special feet were designed and constructed for the ends of the legs. They are attached to the cable and are removable at disassembly time. Tops of the legs are held in specially milled blocks of aluminum which form receptacles for them. To make them easy to remove, the legs are just a slip fit in the blocks. Integrity of the structure is provided by the tensioning cables on the bottom, and once assembled the whole structure is quite sturdy. Since this frame is a handmade prototype and no two legs are identical, they are color coded to the blocks (each one different) for proper assembly.

At the center of the beam, a rotating arm is supported on a shaft which is held in a bearing support block in the beam. This arm is four feet in length, and made up from a hardened .5" diameter bar and a special two foot support "T" in its center span. The arm follows and supports the child as he moves about under the beam. For added flexibility, a carriage riding on a linear bearing on the rotating arm permits movement in a radial direction around the axis of rotation of the arm. Special stops prevent the carriage from running off the end of the bar.

Length of the legs is such as to have sufficient clearance for the arm above the ground to permit the child and harness assembly to fit. This distance was four feet, and the legs then are slightly longer than that. Weight of the entire apparatus including the carrying case is twenty five pounds. This is of the same order of weight as the child himself and does not pose a burden when carrying over short distances. Limiting static load capacity of the frame is the linear bearing which rides on the rotating arm. This will support well over four times the 25 lb. weight of the child in the loading configuration we are using. With the present abilities of the child in question, impulse loading on the structure is not expected to be a factor.

Cost of materials for the support frame was $389.24.



SUPPORT FRAME

(with harness)

"Head Position Sensor"
A Programmable Head Position Sensor for the Developmentally Disabled

Designer: Drew Amery
Disabled Coordinator: Mark Frasier, Sunland Training Center
Supervising Professor: Dr. Robert J. Hirko
Aerospace Engineering, Mechanics, and Engineering Sciences
University of Florida
Gainesville, FL 32611

INTRODUCTION

The Head Position Sensor(HPS) is a tool that can be used by physical therapists to help teach correct head posture to people who lack the necessary motor control. The device consists of a sensing helmet worn by the patient and a separate Control & Interface unit. The Helmet and the Control unit are coupled by a wireless infrared link. The helmet transmits a signal to the control unit whenever the patient's head is within the programmable X and Y inclination limits, as set by the therapist. Upon receiving the transmission, the control unit can operate in one of two modes - direct or delay. In the direct mode, the controller turns the selected output device on when the signal is transmitted and off when it is not. In the delay mode, the therapist can program a time delay for the turn on of the output. This delay can be from 10 sec to 5 minutes and 30 seconds.

A third generation device, this head position sensor allows the therapist to control the angle and time parameters, parameters that were fixed in previous generations.

SUMMARY OF IMPACT

The patients with Cerebral Palsy who may benefit from this device are severely involved, non-ambulatory individuals who usually require external support to maintain a functional sitting position. The inability to support their head in a vertical position has a profoundly negative impact on their perceptual-motor, cognitive, and social development. External head supports are usually contraindicated since these tend to inhibit the development of head control and subsequent developmental skills.

The head position sensor activates any electrically operated device that might act as a positive reinforcer. Activation occurs only when the head is in a relatively vertical position. The angles of activation are adjustable in the forward/backward and side to side planes. Time span between the initial stimulus (head in vertical) and the activation of the positive reinforcer can also be adjusted from 0 seconds to 5 minutes in 10 second increments. The time delay and the angle limit adjustments allow the device to be gradually re-adjusted as the individual's head control improves, so that he is encouraged to support his/her head more vertically, and for longer periods of time.

In the past, devices of this type usually employed glass encased mercury switches as position sensors. The sensors on this device contain a saline solution, thus eliminating problems with using mercury. In summary, the adjustability, safety, and low weight of this device make it vastly superior to other devices that we have used.

TECHNICAL DESCRIPTION

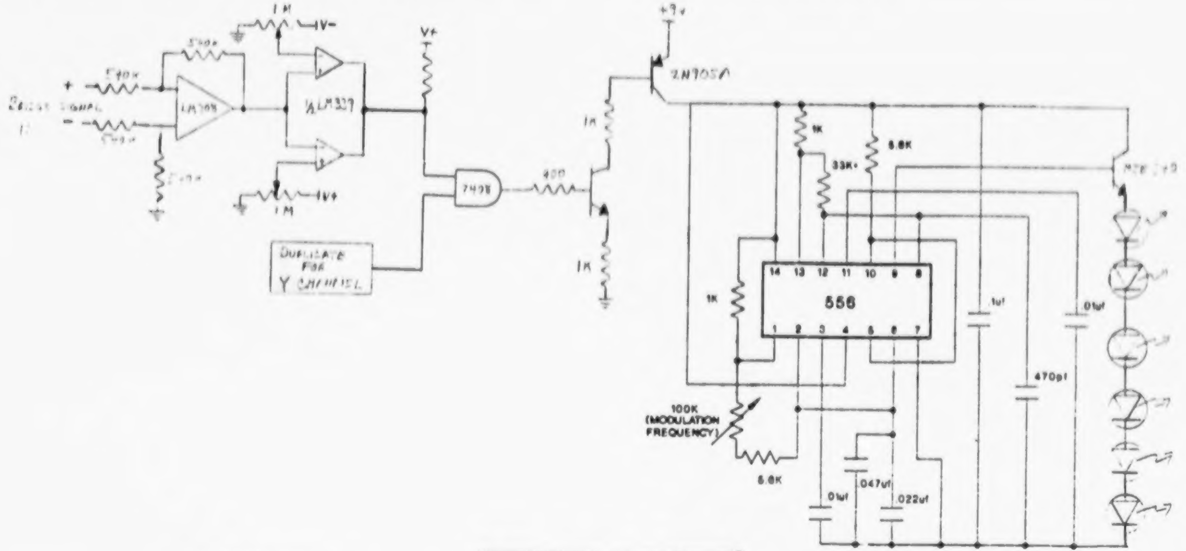
The device is divided into three units, a helmet which contains all inclination sensing and logic circuits, a receiver which contains a infrared receiver and delay circuitry, and a programming device to make the angle programming of the helmet easier.

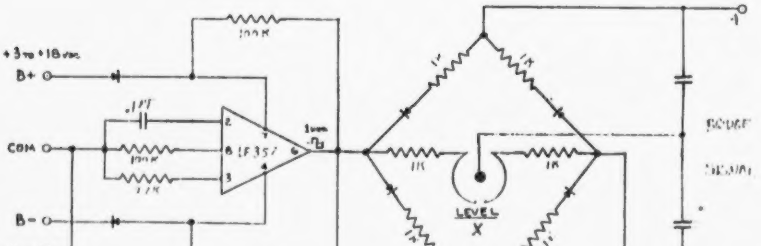
The helmet utilizes two electrolyte bridge level sensors to separately measure the X and Y angles of inclination. Each of the bridge units is modulated at khz with a 1 volt square wave signal. The bridge signals are rectified into bipolar DC levels (positive dc for clockwise movement and negative for counterclockwise movement). The output of the rectifier section is a voltage proportional to the angle of inclination from vertical. Both X and Y signals are then fed into a LM308 opamp to convert from a double ended to single ended output. Each of these signals goes into a window comparator constructed from a LM339 (1/2 of a LM339 for each). The reference voltages for the detectors are provided by 1 Meg trimpots tied to +/- V. Outputs of the two window comparators (logic high if within window) are anded together. The anded logic signal is fed into two switching transistors to control the power of an LM556 dual timer which provides a 200 Hz modulating frequency on a 40 KHz carrier frequency to drive the six infrared LEDs (980nm).

The receiver detects the presence of the infrared signal with a GP1U52X infrared receiver/demodulator module. Output of the detector is logic low when an infrared signal is detected. This logic signal is then fed into an LS7210 delay timer. The timer is programmable through an 8 pin dip switch accessible through the front panel. The output of the timer is fed into a four position slide switch. This switch allows the therapist to switch between three different low-voltage switching outputs and one 110 volt switching output.

The programming device consists of a four position switch, a five wire ribbon cable and two jacks to which are attached a digital voltmeter. This allows the therapist to quickly adjust threshold voltages for all four angles by just turning a switch and adjusting a pot.

Parts and supplies for the Head Position Sensor cost two-hundred ninety five dollars ($295).


1M
V-
V+
+9v
2N905A
Bridge Signal
LM308
1/4 LM339
7408
470
1K
DUPLICATE FOR Y CHANNEL
1M
V+
14 13 12 11 10 9 8
556
1 2 3 4 5 6 7
33K
6.8K
1uf
.01uf
470pf
100K (MODULATION FREQUENCY)
6.8K
.01uf
.047uf
.022uf


100K
+3 to +18 vdc
B+
COM
B-
-3 to -18 vdc
LF357
1 vpp
1K
LEVEL X
100K
+
BRIDGE SIGNAL
-

HELMET

"The S.C.O.O.T.E.R."
A Human-Powered Vehicle for a Cerebral Palsy victim

Designer: Herbert L. Sivitz
Disabled Coordinator: Richard Healy, Res-Care 39th St. Cluster
Supervising Professor: Dr. Robert Hirko
Aerospace Engineering, Mechanics, and Engineering Science
University Florida
Gainesville, Florida 32611

INTRODUCTION

The S.C.O.O.T.E.R. (self-propelled cruiser operating on therapeutically engineered rehabilitation) is a therapeutic device designed for a specific individual with congenital Cerebral Palsy and severe Scoliosis. It allows for self-propelled transportation. The person lies in a prone face-down position and pulls the up-right levers towards himself for forward motion. This action can create muscle strength and tone in the arms and back of the individual. Orthotic devices are used to hold to his wrists to the levers. This will aid in the correction of the person's wrist deformities. The chassis is designed with a body-mold of his upper torso and for his hips and legs, cushions are used as guides to keep him in a comfortable position. This will help to correct his Scoliosis.

The individual will be closely monitored by physical therapists and aides when using the SCOOTER. Due to the person's disabilities, he is unable to operate conventional apparatus of this type.

SUMMARY OF IMPACT

Tony is a 25 year old young man who is profoundly mentally retarded and non-verbal. He also has Cerebral Palsy which effects the muscle tone in his arms, legs, and trunk (severe spastic quadriplegia). He has severe Scoliosis of the spine and limited range of motion of his arms and legs. He is unable to roll over or sit up. Tony can extend his neck and turn his head from side to side. He is also able to reach for objects with his left arm. He appears to have good vision and communicates by either smiling and laughing or by grimacing and groaning. Tony is totally dependent on others to provide for all his self-care and daily living activities. He is totally dependent on others for mobility.

The primary goal of the custom prone scooter is to give Tony the ability to move himself through space for the first time. He may learn to control his movements without depending on staff. Outdoors, Tony could experience self-powered mobility for the first time and perhaps benefit from the cardiovascular demands of the arm pumping mechanism. Beyond these benefits, the feeling of accomplishment would certainly have positive effects on Tony.

The scooter may also yield several secondary benefits. The contoured molded trunk support corrects Tony's scoliosis and maintains his trunk in better alignment than when he is in other positions. His legs are also maintained in better alignment when in the device. This customized prone position is far superior to the prone position in which Tony can be placed using commercially available equipment. This improved positioning should help prevent the progression of Tony's deformities, improve circulation, and increase lung expansion. Also, because of its height, it allows Tony to make eye contact with those around him without hyperextending his neck. This will allow staff to run a variety of programming with Tony while he is positioned on the device.

TECHNICAL DESCRIPTION

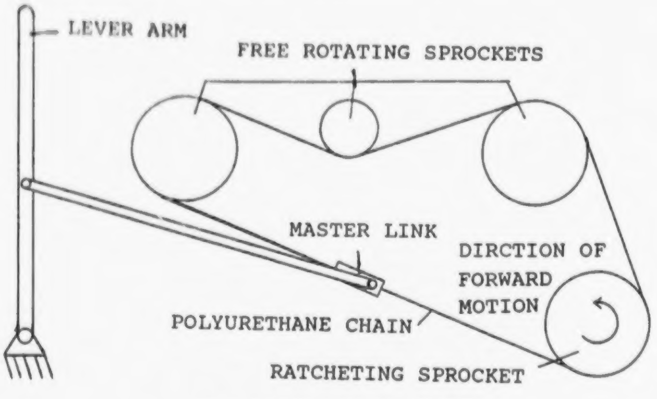
The specifications for the physical design criteria were; his weight, 70 lbs-m, the maximum force in his arms, 10 lbs-f in his left arm and 4 lbs-f in his right arm, his limited range of motion, +90 degrees to -45 degrees forward to backward of his upper arm about his shoulder with respect to the body line, zero degrees to +90 degrees outward away from his body of his upper arm and +30 degrees to +170 degrees for an elbow angle and little control of his wrists, and his cognition. For modeling computations, the weight of the vehicle, 70 lbs-m, and the maximum acceleration of the SCOOTER, 1 ft/sec^2, were arbitrarily chosen. A factor of safety of two was selected in order to assure the security of the individual.

The overall dimensions of the SCOOTER 64 inches long, 33 inches wide, 42 inches high and weighs approximately 55 lbs-m. The chassis is constructed entirely of 6061-T6 aluminum. The supported pan is one piece of 50 thousandth inch aluminum riveted together. The pan is supported by a truss of one inch by one inch by one-eighth inch angle and is capable of withstanding loads greater than 200 lbs-f. The rear wheels are 20 inch wheelchair wheels and are fixed to the rear axil. The front wheels are 8 inch casters, also from a wheelchair.

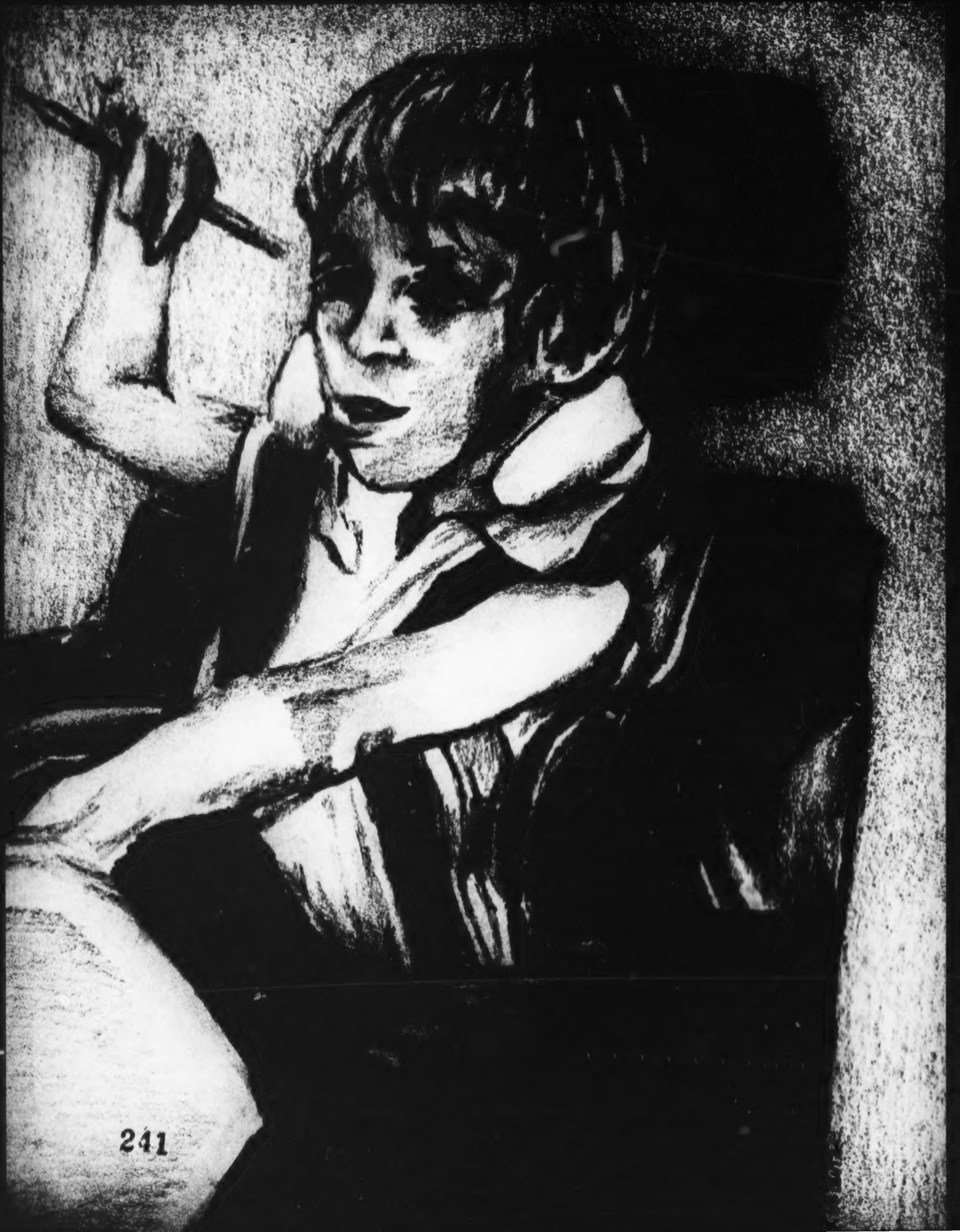
There are two sets of drive systems, one for each lever arm. The drive systems consists of three free-turning sprockets, one ratcheting sprocket and a light weight polyurethane chain. The master link also acts as the connection point for the members attached to the lever arm. The lever arms rotate about a bar fixed to the chassis and extend upward by the head. They are fixed shoulder width apart. Orthotic devices, molded plastic with velcro straps, are attached to the lever arms at shoulder height. These orthosis are used to secure the individual's hands and wrists to the lever arm in order that he may concentrate his strength on working the levers and not holding up his arms. The individual normally uses this device to correct his wrist and hand deformities. The action of pulling the levers towards himself facilitates forward motion. The levers are then free to ratchet back for the next stroke. For safety, the chain drive system is shielded by an aluminum sheet.

Due to the individual's cognitive skills, the SCOOTER is not equipped with steering capabilities, and for the same reason, there is no reverse mode. There is a wheel lock and this is to be used by the monitor to aid in turning the vehicle. The SCOOTER is meant to be used on flat level ground such as a hallway or sidewalk.

The SCOOTER cost five-hundred three dollars and eleven cents ($503.11) to build. It was created to be highly specialize for the intended individual, with some modifications it could be redesigned to be a useful mode of transportation to others capable of mastering a more complex vehicle.



DRIVE SYSTEM



CHAPTER 15

UNIVERSITY OF HOUSTON
CULLEN COLLEGE OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING
HOUSTON, TEXAS 77204-4792

Principal Investigator:

Robert H. Allen (302) 451-2421

A Walking Aid for a Handicapped Child

Designers: Gerald Douglas, Jacob Ho-Tung, William Puccio, Joe Spiller
Disabled Coordinator: Myron Friedman, T. H. Rogers School
Supervising Professor: Robert Allen
Department of Mechanical Engineering
University of Houston
Houston, Texas 77204-4792

INTRODUCTION

A walking aid for a multihandicapped student has been designed, built and tested. The intention of the device is to assist a student who is physically capable of walking but may lack the confidence, coordination or willingness to do so. The device is designed to satisfy the special requirements of a particular student, but, in general, it is useful for training anyone weighing up to 100 kilograms with similar handicaps.

A variant design of a commercially-available walking aid led to an A-shaped gantry fabricated from welded square aluminum tubing. A manual winch with suspension straps support the body harness that keeps the student in place within the device. Large diameter front wheels, rear swivel casters and caliper brakes are also incorporated in the design to control the motion of the walking aid. To encourage the student the walk, the device is equipped with a motion-sensitive music system. The entire system, along with a test subject, is shown below.

SUMMARY OF IMPACT

A walking aid has been designed, built and tested to help a multihandicapped student walk independently. With such a device, it is hoped that this student, and perhaps others like her, can learn to walk without assistance or supervision for extended periods of time. The primary contribution of this device is that once a subject is secured in the walking aid, the probability of falling over is very small because the system is statically and dynamically stable independently of the actions of the subject. In addition to providing a safer environment for the subject, attending staff members or family members do not have be on constant alert for safety concerns. Finally, by adjusting the height of the support harness, it is hoped to teach the student to gradually support her own weight and become more independent.

TECHNICAL DESCRIPTION

The walking aid consists of four subsystems: gantry frame, suspension, motion regulation and electronic circuit. Each subsystem is described below:

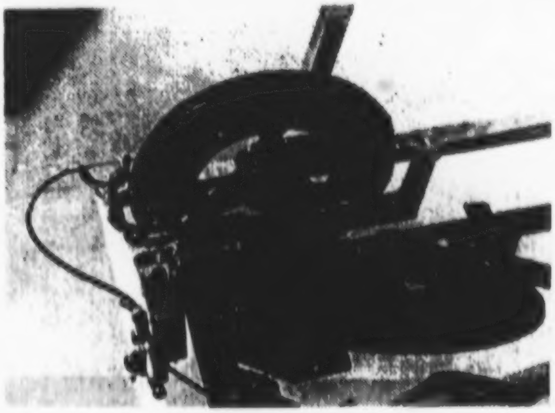
The **gantry frame subsystem** consists of the welded aluminum structure, to which all other subsystems are attached. The aluminum used, 6063-T52, was chosen because of its weldability, excellent finishing characteristics, machinablility, corrosion resistance and relatively high (21,000 psi) yield strength. The frame is capable of supporting a load in excess of the 200 pound design load. The physical dimensions of the walking aid are 73.75" high x 31" wide x 46" long. The frame is tall enough to accommodate a subject 68" tall and long enough to provide a full walking stride of 24." Although the width and height of the frame are constrained by standard interior door dimensions (80" x 32"), the frame dimensions have proven to be stable during loading, operation and unloading. As shown below, the erect gantry frame may be collapsed for transporting or storage by removing eight pins (two at each side link, two at the bottom of each of the lower front links near the front wheels).

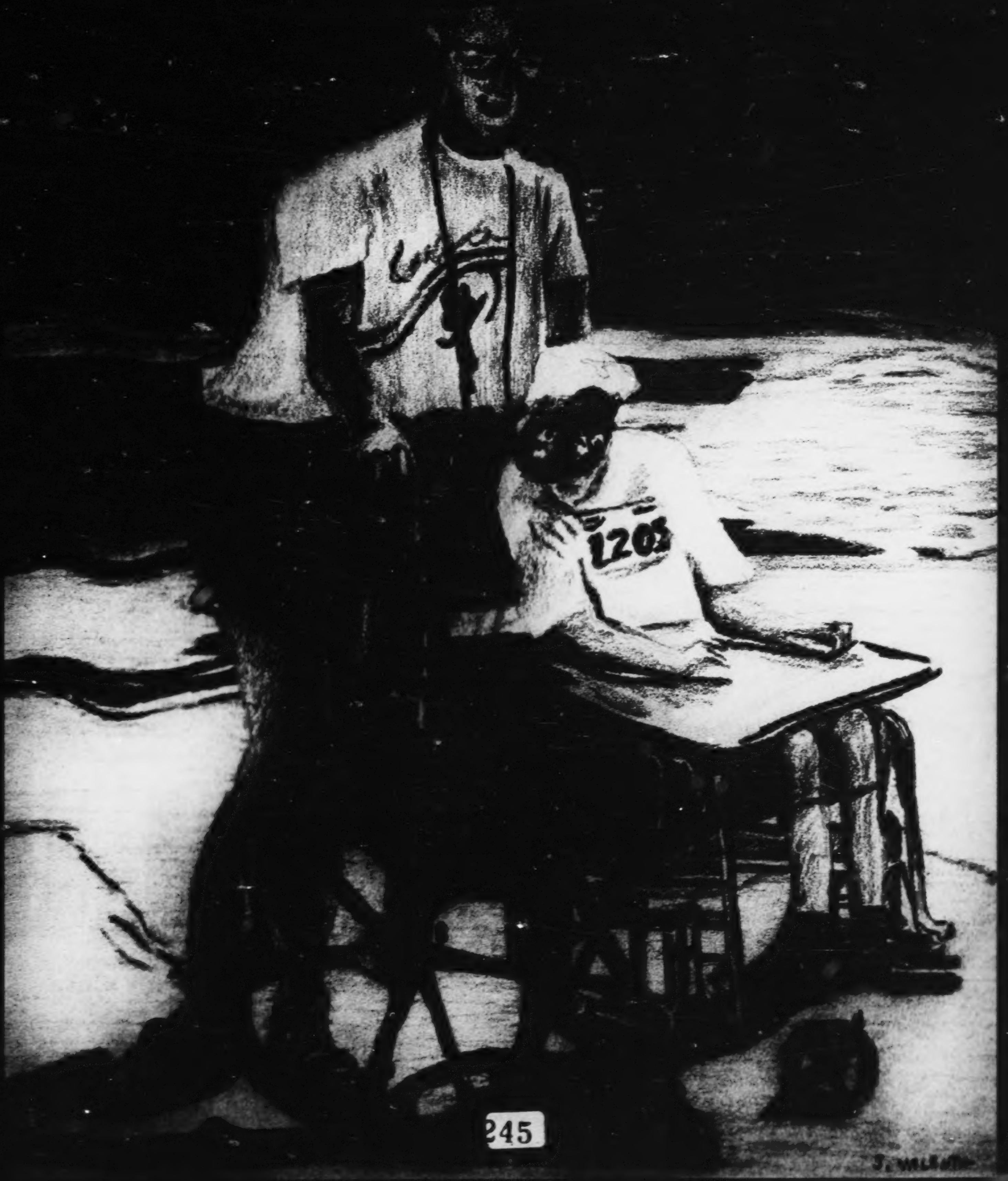
The **suspension subsystem**, depicted below, consists of a manual winch, suspension straps and a full body safety harness. The harness has an ANSI Class III rating, which adjusts to fit subjects ranging in height from 58" to 68." One inch wide straps that attach radially to the gantry frame serve to confine the subject's center of gravity to a safe limit. The manual winch is a typical boat-trailer winch. The winch controls the elevation adjustment of the student as well as providing a simple way of placing the subject into and out of the walking aid. The winch has a gear ratio of 3.2 and a crank handle length of 6.75." The mechanical advantage of 36 allows a 200 pound subject to be lifted and lowered using a force of less than six pounds.

The **motion regulation subsystem** consists of two 12.5" diameter front wheels, two rear caster wheels and the brake system. The combination of wheels were selected to prevent the walking aid from tipping over if a change in ground elevation is encountered. It has been determined that a 1" high obstacle can be overcome with a force of 23 pounds with no danger of tipping. The brake system has been incorporated to keep the walking aid stationary during unexpected or undesirable situations.

The **electronic circuit subsystem**, depicted below, consists of a transistor radio, a timing circuit and a magnetic proximity switch. The timing circuit is powered by a standard nine volt battery and includes an adjustable playing time. The purpose of the this motion-sensitive system is to provide a musical incentive for the subject to walk.

The material cost of the walking aid is close to $1,000.

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CHAPTER 16

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
COLLEGE OF APPLIED LIFE STUDIES
DIVISION OF REHABILITATION EDUCATION
COLLEGE OF ENGINEERING
DEPARTMENT OF GENERAL ENGINEERING
CHAMPAIGN, ILLINOIS 61820

Principal Investigator:

Mark G. Strauss (217) 333-4613

"Voice Amplifier"

Designers: Heidi Blaumueller, John Connelly, Mike Kloos
Supervising Professor: Dr. Mark Strauss
Division of Rehabilitation Education and Department of General Engineering
University of Illinois at Urbana-Champaign
Champaign, IL 61820

INTRODUCTION

An amplifier/speaker was modified for use by an individual who is incapable of speaking above a whisper and who has quadriplegia. A phone headset was installed and the unit was adapted accordingly. The phone headset enables the individual to utilize a microphone without the use of his hands, and the proximity and sensitivity of the microphone prevents strain on his voice. In the initial unit, the switch to activate the amplifier was not accessible to him. A switch with a longer lever was installed in more convenient location, enabling the individual to comfortably turn the unit on or off. This amplifier lets the individual communicate more easily. He can now participate in classroom discussions, making his thoughts better known to others.

SUMMARY OF IMPACT

A 27 year old incomplete 5th cervical fracture, quadriplegic and legally blind student, was involved in a car accident in 1980. Also as a result of the accident, he sustained permanent damage to his vocal cords, which resulted on minimal voice projection.

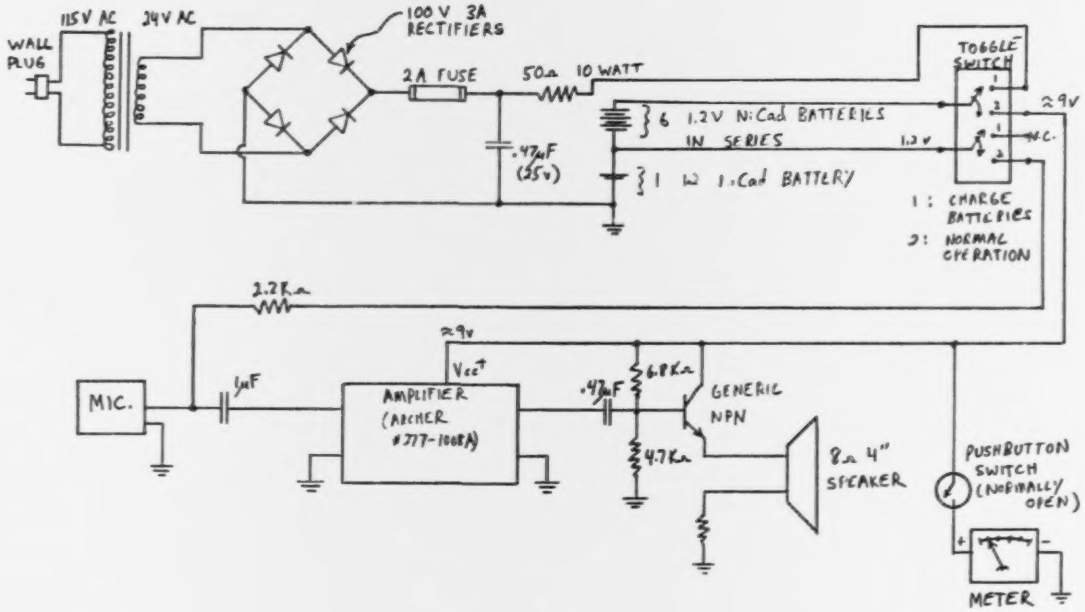
He started at the University of Illinois in 1987 in the College of Liberal Arts and Sciences as a premed student in psychology. It was immediately identified in the social and academic settings that his ability to communicate only in a whisper was greatly hindering his performance and socialization. He could attend classes but was unable to take part in group discussions or have his responses or needs expressed without someone interpreting for him.

A voice amplifier was designed and built by the engineering students that now allows him to communicate in a normal tone of voice in the classroom and socially.

He will continue to be able to utilize the voice aide in his established profession to counsel clients and communicate with colleagues in the department of psychology.

TECHNICAL DESCRIPTION

An Archer mini amplifier/speaker (cat#277-1008A: $11.95) was modified for use by an individual who was incapable of speaking above a whisper. Additional circuitry was added so that an ultralight phone headset with an electret microphone (ACS Communications: Model#: SW52: $60.00) could be used with the unit. The electrical components added were a 2.2K ohm resistor ($.10), and a 1 microfarad capacitor ($.15) (See circuit diagram). Other added features were a rechargeable battery supply with charging circuit ($72.84) (see circuit diagram), a larger 4" 8 ohm speaker (~$5.00) and a current amplifier stage (~$2.50) (see circuit diagram). The output stage is better able to drive the larger speaker than the original amplifier alone and thus minimizes distortion. The entire unit was housed in a Radio Shack metal project box ($10,49). A 1/8" hole was drilled into the casing for the on-off switch, and a two conductor 1/8" mini phone jack (Archer: cat#274-251A; $.53) was installed. In addition, the power switch was replaced and moved. This was done for two reasons. Because the individual is a partial quadriplegic and has limited use of his hands, he was incapable of turning the unit on. A power switch with a longer lever was installed so that the individual could apply the same amount of force to the lever and cause a greater moment, thereby enabling him to turn on the switch. The recharging circuit consists of a step down transformer to change 115V AC into 24V AC. This is then run through a rectifier bridge and capacitor to change it to DC. This charges the battery pack when the switch is in the charge position. Also added was a voltmeter to test the battery voltage level. The amplifier/speaker needed to be mounted as far as possible from the microphone (to diminish feedback), but still accessible to the individual. It was attached with Velcro to the side of the wheelchair, and while feedback is still a problem, it is minimal.


115V AC
24V AC
WALL PLUG
100 V 3A RECTIFIERS
2A FUSE
50Ω 10 WATT
.47μF (25v)
6 1.2V NiCad BATTERIES IN SERIES
1.2 v
1 1.2 NiCad BATTERY
TOGGLE SWITCH
1
2
1
2
≈9V
N.C.
1 : CHARGE BATTERIES
2: NORMAL OPERATION
2.2KΩ
≈9v
MIC.
1μF
Vcc+
AMPLIFIER (ARCHER #277-1008A)
.47μF
6.8KΩ
4.7KΩ
GENERIC NPN
8Ω 4" SPEAKER
PUSHBUTTON SWITCH (NORMALLY OPEN)
+
-
METER

Foot Control of a Cassette Player

Designer: Michael Kloos
Disabled Coordinator: Janet Floyd, University of Illinois
Supervising Professor: Dr. Mark Strauss
Division of Rehabilitation Education and Department of General Engineering
University of Illinois at Urbana-Champaign
Champaign, IL 61820

INTRODUCTION

Some blind and visually impaired students record their lectures using a tape recorder in place of taking written notes. One university student enrolled in the College of Law does this and then transcribes the voice recordings into braille in the evenings.

Using a brailler requires two hands. Starting and stopping the cassette player required the student to remove one of his hands from the brailler, locate the appropriate buttons on the cassette player, then transfer back to the brailler. These repetitious movements slowed down the brailling process almost to a point where the process of transcribing was not an effective use of his time.

In order to make the transcribing process quicker and more efficient, a simple modification was added to the cassette player to pause the tape by foot activation.

SUMMARY OF IMPACT

A 29 year old man, legally blind since birth, and a law student at the University of Illinois was able to tape lectures but required some means of getting notes brailled. He found it too time consuming doing it himself and sought assistance from the NSF Rehabilitation Engineering program.

An engineering student was able to develop a foot operated on and off switch for his cassette recorder so he was able to have both hands free to braille.

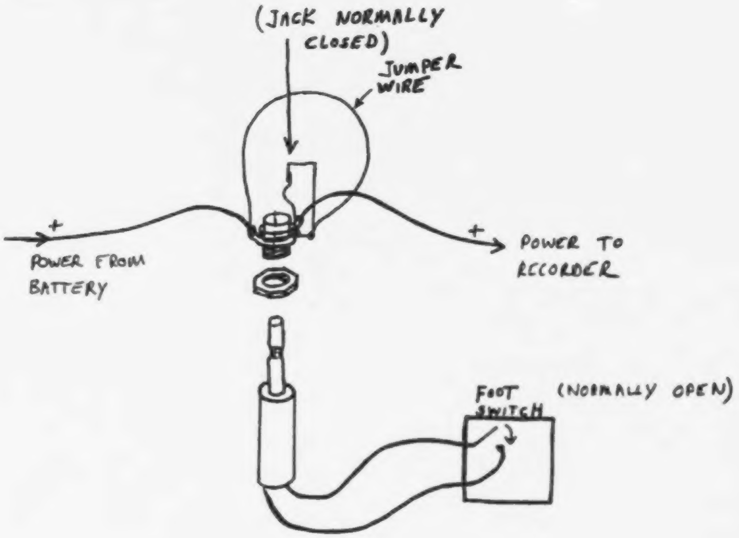
This modification will continue to aid this individual in his profession once he has passed the bar exam by allowing him to prepare his briefs for the courtroom.

TECHNICAL DESCRIPTION

The blind individual was using a Panasonic RX S20 radio cassette player which had an electronic on/off pause control. Initially it was decided to connect an external switch in parallel with this pause control switch. When the cassette player was disassembled it was found that this switch is a double pole double throw variety, which made the anticipated simple modification more complex. Without being able to determine which of the terminals will be appropriate ones to connect an external switch to, the service manual was obtained from the Panasonic Company in order to study the schematic and make the appropriate decision. After receipt and study of the electronics diagram, it was decided that incorporating a simple external switch interfaced to the internal pause control switch was too difficult.

The final, simple modification was to connect an external single pole single throw foot-operated switch in series with the DC power supply. A jack was installed in the wall of the cassette player and wired so that normal operation would not be affected when the foot switch was not plugged into the jack. When the foot switch was plugged into the jack, power was disconnected when no foot pressure was applied to the switch. Power to the cassette player was present as long as the foot switch was depressed.

Both the jack and the foot switch can be obtained at a Radio Shack store. The total cost for this project was $4.



Microwave Oven Alert System

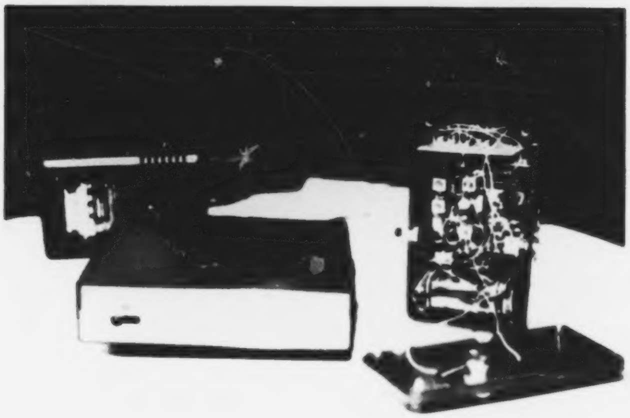
Designers: Bob Bryant, Bob Bucciferro
Supervising Professor: Dr. Mark Strauss
Division of Rehabilitation Education and Department of General Engineering
University of Illinois at Urbana-Champaign
Champaign, IL 61820

INTRODUCTION

This project was designed to help a hearing impaired person with the use of a microwave oven. The person, because of her hearing impairment, was unable to hear the buzzer that signaled the microwave oven had turned off. To solve this problem, a wireless alarm system was modified. A switch was installed on the microwave oven to detect when it had turned off. This switch activated the alarm transmitter which, in turn, signaled the receiver. The receiver, was small and portable and was modified with an additional circuit so as to flash a light when the transmitter signaled. This light would inform the hearing impaired person that the microwave oven had turned off.

SUMMARY OF IMPACT

For a deaf individual who lives by herself, the constant monitoring of the microwave oven during cooking restricted her from her other chores. Her request for a device which could notify her when her microwave oven's cooking cycle had ended has been implemented successfully. By carrying around a small 8 oz. receiver, she can be notified by a blinking light on the receiver that the microwave oven has finished its cooking cycle. This allows her to perform more of her tasks at a greater distance from her kitchen than she normally could without this design.



TECHNICAL DESCRIPTION

This project used a wireless alarm powered by an external twelve volt transformer. The transformer was connected directly to the power inputs on the back of the transmitter. The only other modification made to the transmitter was the connection of a long lever-type switch in parallel to the "page" button.

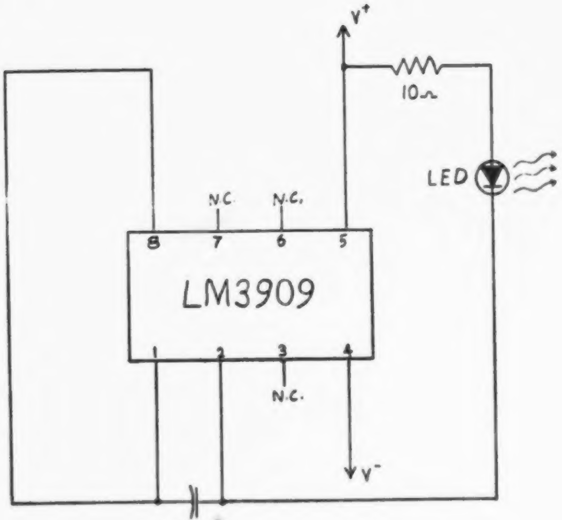
A LM3909 National Semiconductor integrated circuit was used to produce a flashing circuit. This circuit was spliced into the receiver circuit in series with resistor #36 which provided power for the flashing circuit. This connection in series with resistor #36 was used because when the receiver was triggered by the transmitter, there was a constant voltage and a constant current present across this resistor. The only other modifications to the receiver were to the switches. Due to the difficulties encountered when trying to remove the existing switches, a new on-off toggle switch along with a new "reset" momentary switch were connected in parallel to the old switches.

When the circuits were completed they were placed in a plastic design box. The new switches along with the LED were positioned in our design box where needed. A single nine volt battery, which powered both the receiver and strobe circuit, was also placed in the box. Hot glue was used to secure the circuits in place.

A unique feature of this project is its adaptability. The lever-type switch can easily be replaced by other switches, such as a pressure switch or a photoresistor, allowing the alarm to be used with other appliances.

COST OF PROJECT

Radio Shack #49-791 car alarm	79.95
Radio Shack #273-1653 transformer	19.95
Radio Shack #270-221 design box	1.99
470 ohm resistor	0.19
10 ohm resistor	0.19
350 mf-16V capacitor	0.99
Radio Shack #275-624 SPST toggle switch	2.29
Radio Shack #275-1549 momentary switch	2.59
National Semiconductor LM3909 integrated circuit	1.69
Radio Shack #276-066a LED	1.19
TOTAL	**111.02**



NOTE: V⁺, V⁻ CONNECTED IN SERIES WITH RESISTOR #36

Adapting Toys for Disabled Tots

Designer: Joe Flerlage
Disability Coordinator: Nancy Bradley, Sunnyside Center, Decatur, IL
Supervising Professor: Dr. Mark Strauss
Division of Rehabilitation Education and Department of General Engineering
University of Illinois at Urbana-Champaign
Champaign, IL 61820

INTRODUCTION

The Sunnyside School in Decatur, Illinois, has identified two severely disabled children who would benefit from toys which could be modified so that the children could learn cause and effect relationships and provide for them control of their environment. The Center had provided us with a motorized Santa Claus and a motorized helicopter which they requested external switches be adapted to.

SUMMARY OF IMPACT

Two battery operated toys were modified so that external switch activation would activate the toys. They are being used by two physically disabled students who are enrolled in our program for the severely and profoundly handicapped. They are in a wheelchair and are only able to use their hands for gross pointing or touching and cannot use them to do any activity that requires a fine hand coordination, such as playing with most toys. They are now able to reach out and push on the pedal switch that is mounted on the wheelchair tray to activate the toys.

Through the use of these switch activated toys, we are attempting to teach them the idea of cause and effect plus give them something to do during play time. The long range goal for teaching switch activation is to provide a means for them to activate a computer--for educational purposes and communication purposes.

TECHNICAL DESCRIPTION

In response to their request we installed a 1/8" phone jack in the body of each of the toys and installed the jack in series with the power supply of the toys with the jack in the normally closed position. With an external foot switch of the dimensions of 3x3" plugged into the jack, the children were able to activate the toys' movements and sounds by aiming for and successfully activating the switch. These were simple modifications but greatly appreciated by the recipients.

The cost estimate:

2 Radio Shack foot switches, model 44-610	7.00
2 1/8" jacks and plugs	4.00

A Wheelchair Lap Board Designed for Minimal Attachment and Removal Effort

Designers: Kent Harrison, Scott Lawrence, Ted Niezyniecki
Disability Coordinator: Bettina Sobieski, Occupational Therapist,
Illinois Children's School and Rehabilitation Center, Chicago, IL
Supervising Professor: Dr. Mark Strauss
Division of Rehabilitation Education and Department of General Engineering
University of Illinois at Urbana-Champaign
Champaign, IL 61820

INTRODUCTION

The purpose of this project was to design a lap board which can be attached to and removed from a wheelchair without assistance from an attendant and with minimal effort by the user. The apparatus was designed for use by a girl who has spinabifida and cerebral palsy. She has good strength and dexterity in her left hand but has poor control of her right hand. She uses an Everest and Jennings electric wheelchair (model P8NU26A-770-3VL) which has the joystick controller mounted on the left side. The design consists of a clear plastic lap board, a stand which holds the lap board when not in use, and a permanently attached, magnetic interface which holds the lap board onto the wheelchair.

SUMMARY OF IMPACT

A special lap tray system has been designed so that a disabled individual can independently attach and remove the lap tray from a wheelchair. This person no longer has to wait for staff to find a free moment, during busy parts of the day, to attach/remove her lap tray. The special lap tray system allows for her to independently prepare meals, transport food, and eat. The disabled individual has expressed how nice it is to be able to complete these tasks independently. She feels, as do I, that the lap tray system has improved the quality of her life in making her more independent.

I thank you for opening up this engineering design program to the public. I also thank the engineering students involved in his project for designing a unique and practical lap tray system.

TECHNICAL DESCRIPTION

The lap board was made of 1/2" thick, clear acrylite and was cut to the dimensions shown in figure 1. A strip of plastic was glued around the edge of the board to prevent objects from sliding off. A small slot was cut out near the top of the board where a hook can be inserted. An L-shaped piece of metal was attached to the rear edge of each arm extension on the board so that it can be held to the wheelchair by magnets on the interface. The metal pieces were bent from a 1/8"x1-1/2" steel strip and were screwed into the board on the top surface.

The stand was made from 4, 4-foot sections of 3/8" galvanized pipe. The two forks, which hold the lap board when not in use, each have a downward bend at the end. Attached to the crossbar of the stand are two spring latches and a standard hardware hook which hold the board onto the forks. The stand was attached to a 15"x32", 1/2" plywood base by 6 copper pipe-brackets which were screwed into the base. The front edge of the base was beveled to allow the front wheels of the wheelchair to run up on the plywood easily.

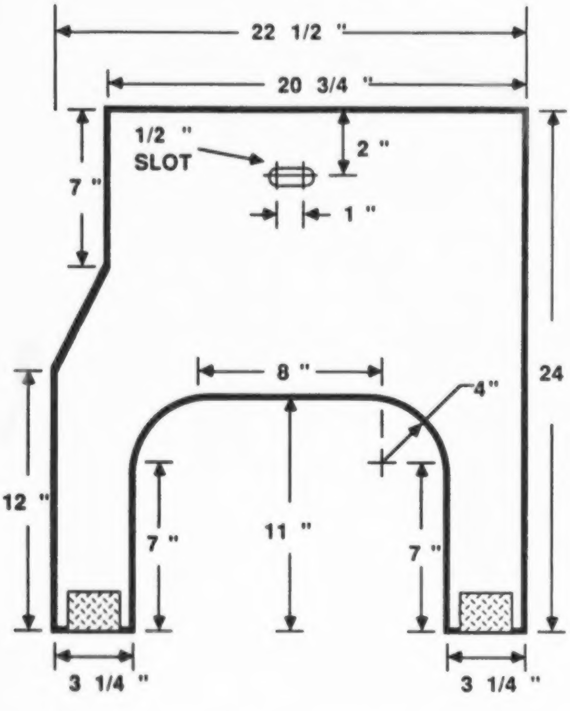
The interface, shown in figures 2 and 3, consists of two units. Each was made from a 3"x6"x1/8" aluminum plate with a magnet attached to each. The plate was bolted to a clamp and was attached to the rear armrest post on each side of the wheelchair so that the magnets lined up with the armrests.

To attach the board to the wheelchair, the user drives her chair under the board while it is held down on the forks. Once in position she removes the hook from the slot in the board and flips up the two spring latches. She then slides the board toward her until the magnets on the interface catch the metal strips on the board. When the magnets engage she can back away from the stand and use the lap board as desired.

To remove the board from the wheelchair for replacement on the stand, the user drives the wheelchair up to the stand so that the slot in the board lines up with the hook on the stand. As she approaches the stand, the board bumps into the curved front of the forks and begins to lift slightly. Once the board is all the way up on the forks, she inserts the hook in the slot and flips down the two spring latches. Since the front wheels of the wheelchair will be resting on the base of the stand, they will hold the stand in place as the wheelchair backs away, and the hook pulls the board away from the magnets.

The final cost of the project was approximately $225. A list of some of the special parts needed is given:

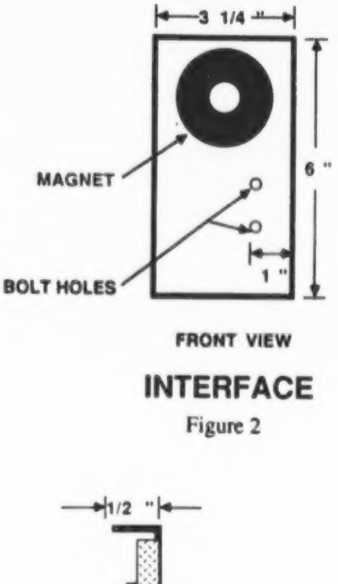
McMaster-Carr (312-833-0300) (#5685K32), 2 magnets
McMaster-Carr (#1302A11), 2 screen door latches.
Hardware store, 4-90 degree elbow fittings (3/8").
Hardware store, 2 "T" fittings (3/8").
Union fitting, (3/8")



1/2 " THICK CLEAR ACRYLITE BOARD

LAP BOARD

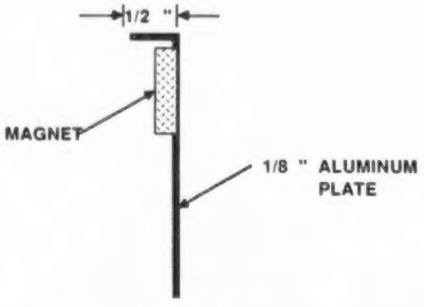
Figure 1



FRONT VIEW

INTERFACE

Figure 2



SIDE VIEW

INTERFACE

Figure 3

Wheelchair Training Device

Designer: Joseph Flerlage
Disability Coordinator: Nancy Bradley, Sunnyside Center, Decatur, IL
Supervising Professor: Dr. Mark Strauss
Division of Rehabilitation Education and Department of General Engineering
University of Illinois at Urbana-Champaign
Champaign, IL 61820

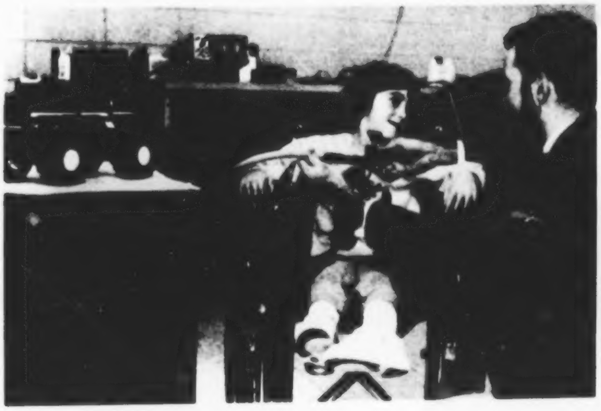
INTRODUCTION

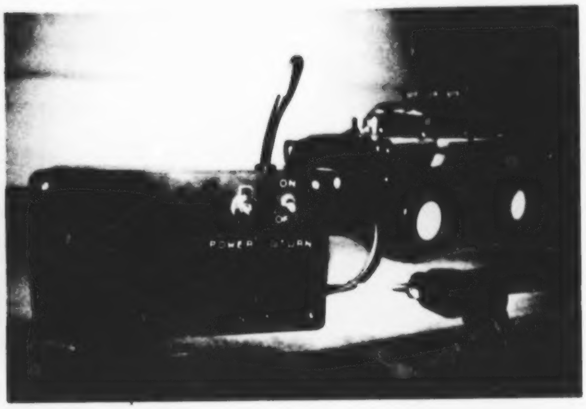
For many children who are physically disabled or mentally impaired, the task of learning how to drive a powerdrive wheelchair is a necessity. For this reason, we at the University of Illinois have developed a device which will help teach a young child with cerebral palsy cause and effect relationships between a wheelchair-type joystick and the corresponding movement in preparation for using a motorized wheelchair with chin control. In addition, the child will practice control of his head movement and have stimulating and entertaining control of his environment.

SUMMARY OF IMPACT

The chin controlled remote controlled car was designed for an 8 year old with severe cerebral palsy who is not able to use his hands for any fine coordination activities. However, he is able to move his head to activate a switch and is showing the ability to learn academic skills and to control his environment through switch activation.

With this remove controlled car, he is learning to maneuver the car operating the joystick with his chin. The primary long range goal for teaching this skill is to assess his ability to use a motorized wheelchair for independence mobility. Secondary goals for this item are to teach joystick activation of a computer for educational and communication purposes and to provide a leisure activity.





TECHNICAL DESCRIPTION

A remote controlled car (RC) was modified to be controlled by a short-throw chin controlled joystick. Most remote controlled cars are controlled by two joysticks or a trigger and a turn knob. On the other hand, wheelchairs are controlled by a single joystick. Our modifications were to basically integrate the two joysticks into one.

The circuitry from an inexpensive (RC) transmitter was mounted onto a bread board so that it would be easy to hardwire the additional electrical components necessary for the modification. The transmitter initially had two poor quality joysticks which had to be operated simultaneously. We removed these joysticks and replaced them with relays which were controlled by a single short throw 4-switch joystick. All of these relays are activated by the movement of the joystick. Four relays were needed in the new design. Because the original circuit required input from both the left-right and forward-reverse joysticks, the relays had to be cross wired so that different configurations were activated simultaneously in order to perform the correct function. A switch was put in series with the left-right relays which could disable them. This would allow only forward and reverse movement, if desired. The modified transmitter circuit is powered by a Ni-CAD rechargeable battery. No modifications were performed on the car itself.

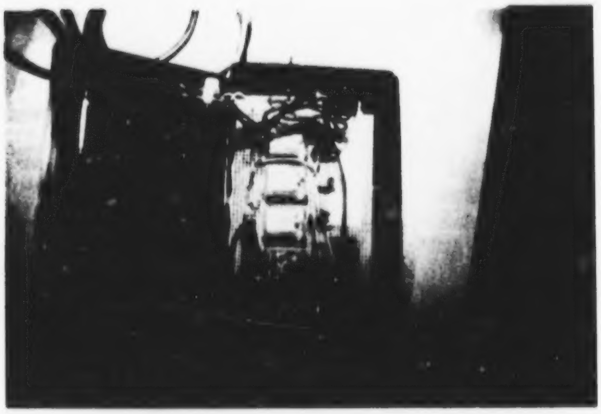
The joystick was mounted to a semi-rigid gooseneck tube. This flexibility allows for easy position adjustment. The "gooseneck" was then mounted to a standard wheelchair control box clamp. With two allen bolts, the clamp is clamped to the frame of a wheelchair. A wrench was also attached to the clamp by a chain.

A wide suction cup was mounted to the joystick handle so that it would be comfortable to operate by the chin. A red dot on the joystick base indicates forward. The joystick can be rotated within its holder, allowing for positioning adjustment which is dependent on the gooseneck clamping location.

With this device a child with limited hand control or poor eye-hand coordination will be able to safely practice chin operated power wheelchair control. The child will be able to sit in a stationary chair while he/she receives entertainment feedback. This will hopefully save time as well as money.

Cost Analysis

Short-throw joystick, Dufco	240.00
Remote control car + transmitter, R.Shack 60-4057	44.95
Battery pack, R.Shack 23-230	24.95
Battery pack charger (control box), R.Shack 23-231	29.95
Experimenter box, R.Shack 270-223	2.99
IC Board, R.Shack 276-1395	1.79
Conductor plug, R.Shack 274-286	1.39
Enclosed jack, R.Shack 274-250	1.79
4PDT relay, R.Shack 275-214	4.69
(3) Mini SPDT relays, R.Shack 275-005 @2.99	8.97
Toggle switch, R.Shack 275-602	1.19
Submini switch, R.Shack 275-612	2.39
Velcro	1.89
Mounting clamp, E&J 90482290	48.90
(4) Nicad batteries (car)	20.00
1 24" Gooseneck, Moffatt Products, 1-800-346-0761	15.00
AC to DC adapter (car), R.Shack 273-1434	11.95
TOTAL	442.79



Wireless Sip- and Puff- Appliance Controller

Designer: Michael Kloos
Disability Coordinator: Nancy Bradley, Sunnyside Center, Decatur, IL
Supervising Professor: Dr. Mark Strauss
Division of Rehabilitation Education and Department of General Engineering
University of Illinois at Urbana-Champaign
Champaign, IL 61820

INTRODUCTION

This report describes the design of a wireless appliance controller to be used by people with severe physical disabilities. The design makes use of a commercially available wireless transmitter and the corresponding receiver/out-let. The transmitter was modified so that activation could be achieved by a sip and puff switch instead of pushbuttons. The transmitter is controlled from a single air tube via sipping or puffing action by the user. A puff on the tube turns the remote switch on and sipping on the tube turns the switch off. The device to be controlled is simply plugged into the receiver and the receiver is plugged in a wall outlet. The transmitter can also be used by a remote switch instead of using the air tube. There are two jacks on the side of the transmitter box for the switch input. When the external switch completes the connection for the jack labeled "ON," the transmitter turns the remote switch on. The jack labeled "OFF" works in a similar fashion. The transmitter unit is housed in a plastic box and connected to a gooseneck tube. The air tube runs from the transmitter box, up through the gooseneck, and out the top to a position near the user's mouth. Since the gooseneck is a semi-rigid tube, it can be bent and adjusted by hand to accommodate any user. A bracket is mounted to a wheelchair and has a socket for quickly disconnecting the transmitter gooseneck unit when not in use. This makes the device more convenient to use.

SUMMARY OF IMPACT

The designed remote controlled appliance controller allows a severely disabled child with cerebral palsy to turn electrical appliances on and off. With the sip and puff switch we will be assessing his ability to use this type of control for future use with other environmental control devices such as a motorized wheelchair.

The ability to activate the transmitter with other types of switches plugged into the transmitter unit also allows variety for this child. This project allows the child more independence, gives him a means of control over his environment, and allows us to use new ways of assessing his abilities for future educational purposes.

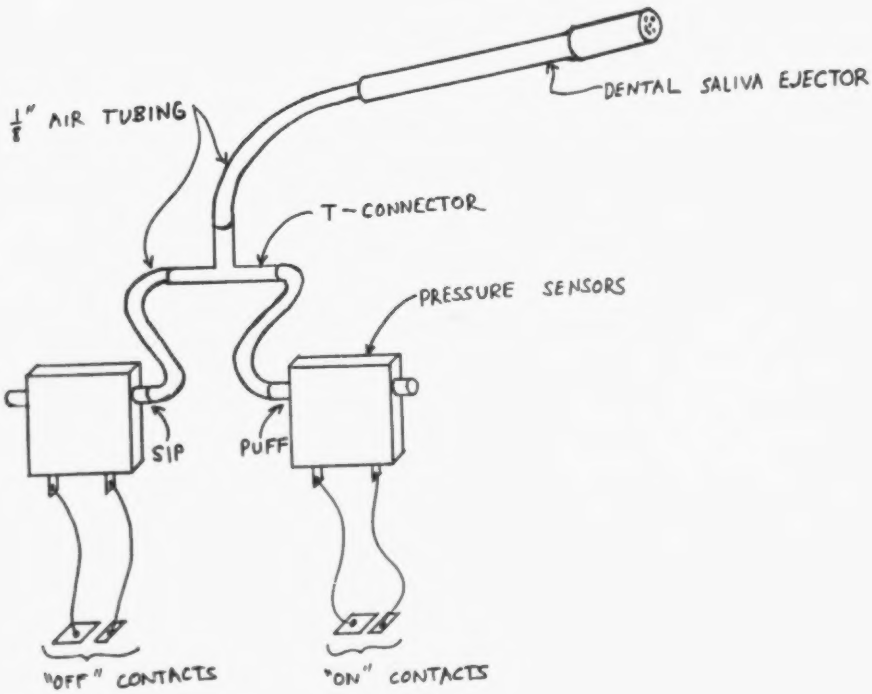
TECHNICAL DESCRIPTION

The transmitter used was a modified Radio Shack remote wireless switch (Cat. No. 61-2667). The on and off contacts from the transmitter were wired to 2 pressure switches manufactured by World Magnetics at 810 Hastings Street, Traverse City, MI 49648, model #8845 (616-946-3800). These were used as the sip and puff sensors. These two sensors were connected by 1/8" air tubing and a "T" connector, obtained at a tropical fish store. The tubing went to opposite inputs on the switches so that one would be triggered by sipping and the other by puffing. Parallel wires from the transmitter inputs were also run to 2 external 1/8" jacks and labeled appropriately. The jacks could accept input from external switches to activate the transmitter. The entire assembly was placed in a Radio Shack plastic project box with the pressure sensors hot glued to the bottom of the box. Holes were drilled for the external jacks as well as for the air tube. 1/2" x 1/16" parallel slots were cut in the top to allow the box to be attached to the gooseneck with a 3" hose clamp.

For ease of installation and removal from the wheelchair, the gooseneck had a quick release coupling which attached the gooseneck and transmitter to a mating male connector. The release male connector was mounted on an Everest & Jennings clamp #90482755 which was then mounted onto the wheelchair. A 1/2" piece of steel bent into an "L" shape and drilled was used to attach the clamp to the male connector. The total cost of the project was about $135.00.

Gooseneck tube in varying colors and end connector configurations can be obtained from:

Moffatt Projects, Inc.
22 Cessna
Watertown, SD 57201
1-800-246-0761



Apple Mouse Sip & Puff Modification for a Person with Quadriplegia

Designer: Heidi Blaumueller and Yuzo Shida
Disability Coordinator: Jann Floyd, University of Illinois Office for the Sensory Impaired
Supervising Professor: Dr. Mark Strauss
Division of Rehabilitation Education and Department of General Engineering
University of Illinois at Urbana-Champaign
Champaign, IL 61820

INTRODUCTION

An Apple Macintosh mouse was modified for use by an individual who has upper limb paralysis. This person needed to use the mouse to complete his class assignments but was unable to simultaneously push the mouse button and accurately move the mouse. In order to remedy this inaccessibility, an external sip and puff switch was installed so that the mouse could be moved with one hand while activated by the sip and puff switch via the mouth. Modifications were performed so that the mouse could be used by able-bodied and disabled people.

SUMMARY OF IMPACT

The significant quality, in practical application, of the "sip and puff mouse" is its ability to increase the capability for independent performance by a user who is severely (i.e., high level quadriplegic) disabled. This adaptive device allows an individual with extremely restricted movement capacity (range of motion) access to those functions normally completed by finger, hand and arm movement(s).

This device has since been accepted by many individuals with severe physical limitations, enabling them to be independent users of computer equipment in completing coursework requirements.

TECHNICAL DESCRIPTION

In order to allow dual operation of an Apple Macintosh mouse (Model number M0100) by able and disabled people, a sip and puff switch was installed in parallel with the switch in the mouse. This was accomplished by performing the followig modifications. The yellow wire from the mouse interface cable was cut at the mouse switch. The end going to the cable was connected to the common of a three lead jack (Archer: cat. no. 274-296: $1.89). The other end of the yellow wire was connected to the lead on the jack which allowed for a normally closed circuit. Another wire was soldered between the remaining lead on the jack and the connection between the internal switch and the rest of the circuit located on the backside of the printed cirucit board in the mouse. A quarter inch hole was drilled into the side casing of the mouse. The jack was inserted through the hole and screwed into place.

An 1/8" plug (Radio Shack #274-288, $1.39) was attached to a sip and puff switch (ComputAbility). When the plug is not inserted into the jack, the mouse switch can be used in the normal fashion. When the plug is inserted, the internal switch in the mouse is disconnected, and the external sip and puff switch is connected.

The plastic tube attached to the sip and puff switch was located near the user's mouth via a goose neck tube. The distal end of the goose neck was attched to a clamp which fastened the fixture to the table edge.

The result of this project is that the individual for which the project was performed could perform his computer assignments independently once the sip and puff switch was attached to the mouse. Accuracy in mouse selections and speed of assignment completion was improved.

Apple Macintosh mouse (Model number M0100)	60.00
Three lead jack (Archer: cat. no. 274-296)	1.89
1/8" plug (Radio Shack #274-288)	1.39
Pressure switch, 0.102 psi (ComputAbility - 201-882-0171)	99.95
TOTAL	**163.23**

The Design of a Rotating Filing System for a Person with Muscular Dystrophy

Designers: Joe Faron, Mark Kaufman, Ron Tamunday
Disability Coordinator: Maureen Kelly, Illinois Children's School &
Rehabilitation Center, Chicago, IL
Supervising Professor: Dr. Mark Strauss
Division of Rehabilitation Education and Department of General Engineering
University of Illinois at Urbana-Champaign
Champaign, IL 61820

INTRODUCTION

The project involved an individual who works for the Illinois Children's School and Rehabilitation Center in Chicago, IL. This person has severe muscular dystrophy and uses a reclining motorized wheelchair. Her project request involved her need for a more functional work station. Previously, all files of work-in-progress and files that are frequently referenced were kept in piles or stacks scattered among two long tables. Due to her condition, most of her strength lies in her ability to pull objects toward her. Dexterity was quite minimal and she could not rotate her hands. She predominantly uses her left hand for handling objects, and her right hand for balancing her upper body and operating the wheelchair controls. Her range of arm motion was limited since she cannot lift her elbows from the wheelchair armrests. Her reach ranged from 15" to 36" above the floor, with her optimal work height being 30". Her optimal work height defines the minimum height of a desk top under which her wheelchair could roll to allow her easy and comfortable access to her work.

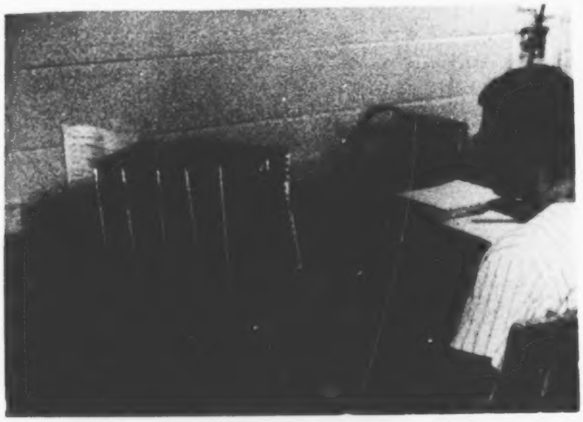
To alleviate a good portion of the work space that was taken up by the piles of stacks of paper, a vertical, rotating filing system suitable for her working environment was built. The files in this system can be accessed from the side, as opposed to from the top, making them accessible to someone using a wheelchair.

SUMMARY OF IMPACT

A person who has muscular dystrophy works for me in an administrative capacity. As her supervisor, I would "cringe" when I walked in her office. She always knew things were, but I never could find anything. I would spend hours looking through piles of files.

The lazy susan type of filing system which the engineering students designed and build is extremely appropriate for the person it was designed for. It is very easy for her to turn and completely accessible to her limited reach and strength. This filing system holds many, many folders and really has expedited her production of work.

We at the State of Illinois Children's School and Rehabilitation Center appreciate the excellent work your students have done.

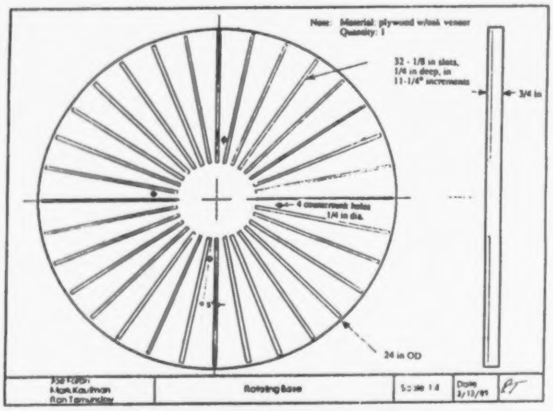


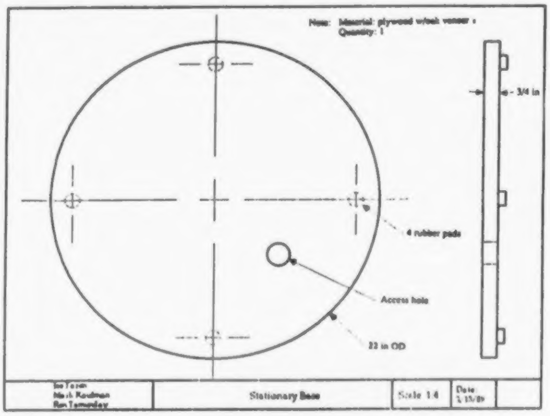
TECHNICAL DESCRIPTION

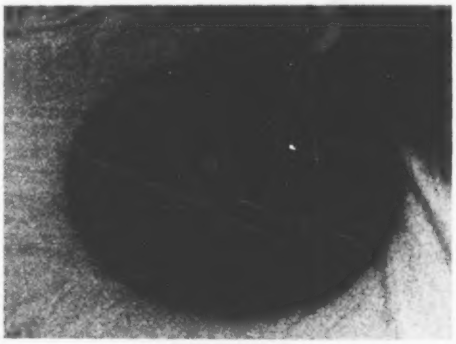
The rotating and stationary base are made of plywood with an oak veneer. The rotating base has an outside diameter of 24" while the stationary base has an outside diameter of 22". The center tube and dividers are made of 1/8" clear plexiglass. The center tube has an outside diameter of 5-1/2". There are 32 dividers equally spaced radially on the rotating base. These dividers have a trapezoidal shape with the base being 9" long and the sides having dimensions of 6" and 8-1/4". The lazy susan bearings used were purchased at a local Ace Hardware Store. The outside diameter of the bearing is 12". It has a loading capacity of 1000 lbs., using 140-1/4" bearings to support this load. 32, 1/8" slots, 1/4" deep were routed on the rotating base as well as a circular slot 1/8" thick with an outside diameter of 5-1/2". The dividers and center tube were secured to these slots by epoxy. The dividers were attached to the center tube with solvent cement, creating a transparent seal. The wood was finished with a polyurethane finish to protect the wood from moisture and to increase its durability. Total cost of the project was $134.43. These costs are summarized below.

Modifications possible for this design include attaching a motor to friction drive the rotating base, and designing the dividers to be removable. If a motor is attached, the stationary base must be modified to accommodate the motor. A motor which can deliver at least 1.5 in-lb. of torque, would be required using the prescribed dimensions and assuming that the total weight of the files plus the rotating base equal 30 lbs. An appropriate motor and speed controller were found in the Bodine Electric Company Stock Catalog (312-478-3515). The prices and model numbers of the motor and controller are included below:

Dividers and center tube		$75.00
Rotating and stationary base		40.00
Bearings		8.34
Polyurethane finish		6.00
Epoxy & solvent cement		5.00
Motor model no. 561		159.54
Speed controller model no. 901		146.08
	TOTAL	$439.96


Note: Material: plywood w/oak veneer
Quantity: 1
32 - 1/8 in slots, 1/4 in deep, in 11-1/4° increments
3/4 in
4 countersunk holes 1/4 in dia.
24 in OD
Mark Kaufman
Rotating Base
Scale 1:4
Date 3/13/89


Note: Material: plywood w/oak veneer
Quantity: 1
3/4 in
4 rubber pads
Access hole
22 in OD
Mark Kaufman
Stationary Base
Scale 1:4
Date



Remote Computer Accessibility for a Person with Quadriplegia

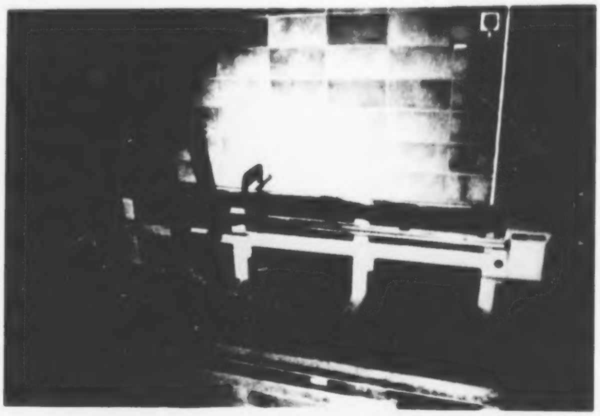
Designers: Bob Klunk and John Antanaitis
Disability Coordinator: James Keefe, Warren Achievement Center, Inc., Monmouth, IL
Supervising Professor: Dr. Mark Strauss
Division of Rehabilitation Education and Department of General Engineering
University of Illinois at Urbana-Champaign
Champaign, IL 61820

INTRODUCTION

A young man who had contracted a brain infection during high school had progressed to the point where this person is a high level quadriplegic. He is completely dependent on others for all tasks and cannot speak. This person's cognitive abilities have not been affected and he is probably above average in terms of intelligence. Prior to our involvement with him somebody had set him up with communications software and a computer so that he was able to communicate by creating sentences with a specialized word processor by using a single push-button. A nearby company has offered this person employment from his bed by using his computer and accessing the company's computer via modem. The client would be required to manipulate the data which, intellectually, he is capable of doing. We were asked to make him more independent by allowing him access to his computer at his convenience without being dependent on another person bringing the computer to him or him to the computer. Since this person has a mild visual deficit, the monitor needed to be within 15" from his eyes. The solution was to fabricate a table on which the monitor would come to the client and retract to its resting location at the client's desire. The project was successfully completed by performing the following design modifications.

SUMMARY OF IMPACT

Our client has high intelligence and a strong need to express his thoughts. Like all of us, his thoughts do not necessarily come only when someone has made his computer accessible for his use, but can come at any time of the day or night. He would never be able to call someone to position his computer at many of these times, which is why the computer monitor positioning table is an invaluable to this client's life. The design which the engineering students have implemented has made possible an independence in computer access not otherwise possible.



TECHNICAL DESCRIPTION

An 8-foot long Stanley garage door opener was used as the drive mechanism to move the table. The garage door mechanism was mounted on the wall parallel to the bed. A light weight table designed as a truss was used to hold the monitor. The table attached to the garage door opener lead screw, as would a garage door, and the truss came up at an angle approximately 30° from vertical, attached to which the horizontal table surface was located. This would allow the table to pass over the client's trunk, legs, and feet during repositioning of the table.

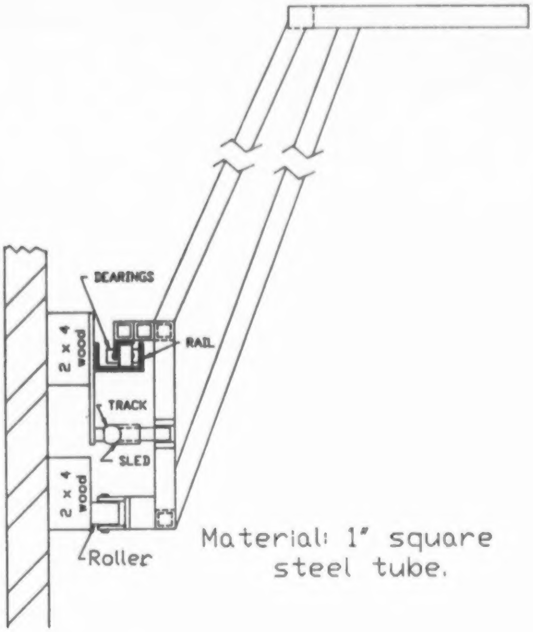
The garage door opening mechanism served only in the movement of the table/frame structure but provided no support for the weight of the structure. In order to hold the table upright, two tracks were fabricated. Channel iron was welded to steel plates and the plates were rigidly affixed to the wall 8" above the garage door opener and parallel to it. A narrow steel plate 3" wide and 8' long was mounted to the wall 8" below the garage door opener track and parallel to it. The lower end of the supporting structure for the table had cam followers and wheels which would interface to these two tracks in the following manner. A total of four cam followers, two positioned horizontally and two positioned vertically, were affixed to the table support and were slid into the channel iron. Two inexpensive rubber wheels were affixed to the lower end of the table support and rolled against the metal plate which was on the wall. The fabrication and alignment of the three tracks and the bearings and wheels was accomplished using a mock-up wall in the laboratory and was created from 2"x4" pieces of wood.

To finish the design a piece of 1/4" masonite was affixed to the tubing onto which the monitor would rest. Two 1/2" foam rubber typewriter mats were than adhered to the top of the masonite, which prevented the monitor from sliding off the table due to any sudden jarring of the table.

As a safeguard, the following materials were provided. The garage door opener was plugged into a timed outlet which provided power only during the hours that the client was awake. At night the power was off, which would preclude the inadvertent activation of the device by extraneous electrical interference emanating from outside the house. In addition, an emergency power shutoff button was mounted in an obvious location on the wall by the bed within easy reach of any caregiver. A doorbell button was also hardwired to the receiving unit which would allow caregivers to initiate table movement in either direction. The installation of the motorized track/table and timed outlet was performed by licensed tradesmen.

The design has been installed in the client's house and is currently being used successfully. The client need only press the remote transmitter which will bring the computer monitor to him or away from him as he so desires. The computer itself does not rest on this table but rests on the floor with the connecting cable running to the monitor. This design allowed for unobstructed access to to the client by his caregivers and the opportunity for this person to be employed. Approximate costs and materials used:

Typewriter mats	22.00
Garage door opener	190.00
8' channel iron and 8' of steel plate	20.00
4 cam followers	20.00
Hardware	10.00
2-3" diameter wheels	5.00
30' of 1" steel tube with a square cross-section	40.00
Timer switch,conduit,outlet box,misc.hardware	50.00
Total	**357.00**



Material: 1" square steel tube.

Title of Project: An Exerciser for a Person with Multiple Sclerosis

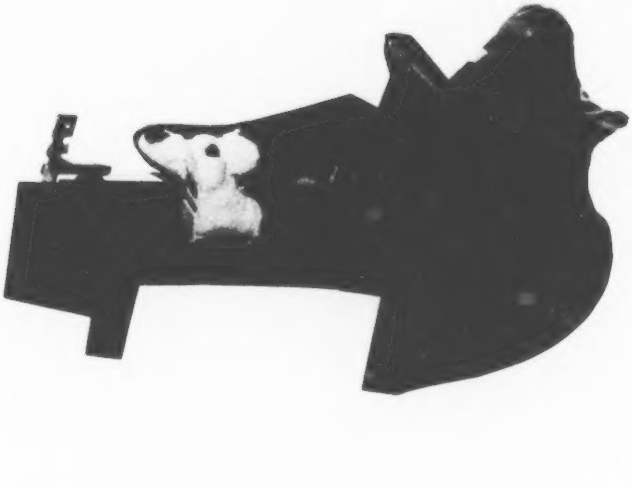
Designer: Heidi Blaumueller, John Connelly
Supervising Professor: Dr. Mark Strauss
Division of Rehabilitation Education and Department of General Engineering
University of Illinois at Urbana-Champaign
Champaign, IL 61820

INTRODUCTION

A middle aged man with multiple sclerosis is concerned about the deterioration of his muscles, especially his leg muscles. By exercising these muscles, he hopes to retard their deterioration. We were asked to design a machine which would enable him to stretch and exercise his limbs while remaining in his wheelchair. The resultant design is such that the user can roll his chair up to the exercise machine and place his feet in the "boots," securing them with velcro straps. By flexing his knees, the "skis" slide backwards in their tracks. If the user wishes, he can also exercise his arms by pulling up on the wooden handles which are attached to the "skis" via a set of ropes.

SUMMARY OF IMPACT

"I am very pleased with the adjustable leg exerciser that the undergraduate engineering students designed and built for me. During the short time which I have used it, the muscle spasms in my legs have eased plus I am getting exercise to my arms also." It is expected that regular exercise with this device will allow the user an increased quality of life due to daily exercise.



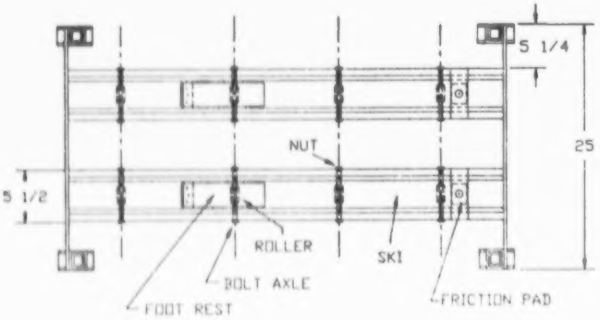
TECHNICAL DESCRIPTION

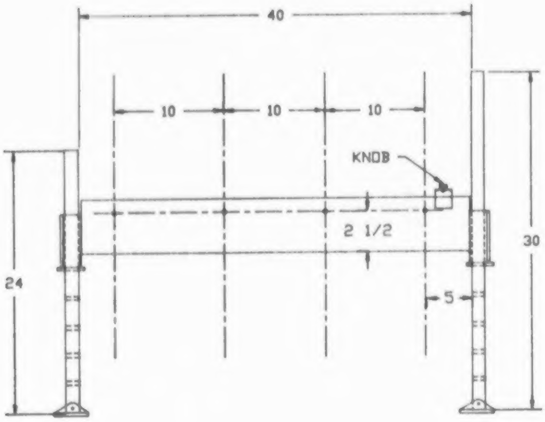
The exercise machine has two tracks, the sides of which are made of 48"x4"x3/4" walnut boards. Each track has a wooden "ski" down its center, supported by four, 2.5" long polyurethane rollers with an O.D. of 1.5" which rotate around a 1/2"x6" bolt. Each "ski" has an adjustable "Bunny boot" hinged to it, into which the user's foot can be placed and secured with velcro straps. A friction pad, made of a wooden block covered with felt, can be tightened at the end of each ski to increase the force (strength) needed to move the ski back and forth, which would therefore alter the exertion level. The tracks are connected by two 30"x4"x1/8" aluminum plates to which four 4" long square aluminum pipes with an inside diameter of 1.005" are welded. Through these pipes another set of square aluminum pipes are fitted with the original outside diameter of 1" being milled approximately 1/100 of an inch. These are used as the legs of the machine, with the front legs being 24" long, and the back legs 30" long. Through these legs 1/8" holes were drilled along the length of each leg at a distance of 2" apart. Four pins, one for each leg, were placed through a hole in each leg, at whatever height the user preferred. This setup made both the height and the angle of the machine adjustable. Ladder feet were bolted to the ends of all four legs to increase the stability of the machine.

A rubber tarp strap can be hooked around the legs of the exercise machine and attached to the wheelchair, keeping the two close together. Two ropes are attached to each ski, near the heel of each "boot." These are threaded through eye hooks and pulleys, leading up to two wooden dowel rods, one for the right ski, and one for the left. The user can pull up on the dowel rod, thereby using the strength in his arms to move the skis and stretch his leg muscles. These can be used to assist the legs if sufficient strength in the leg muscles is lacking.

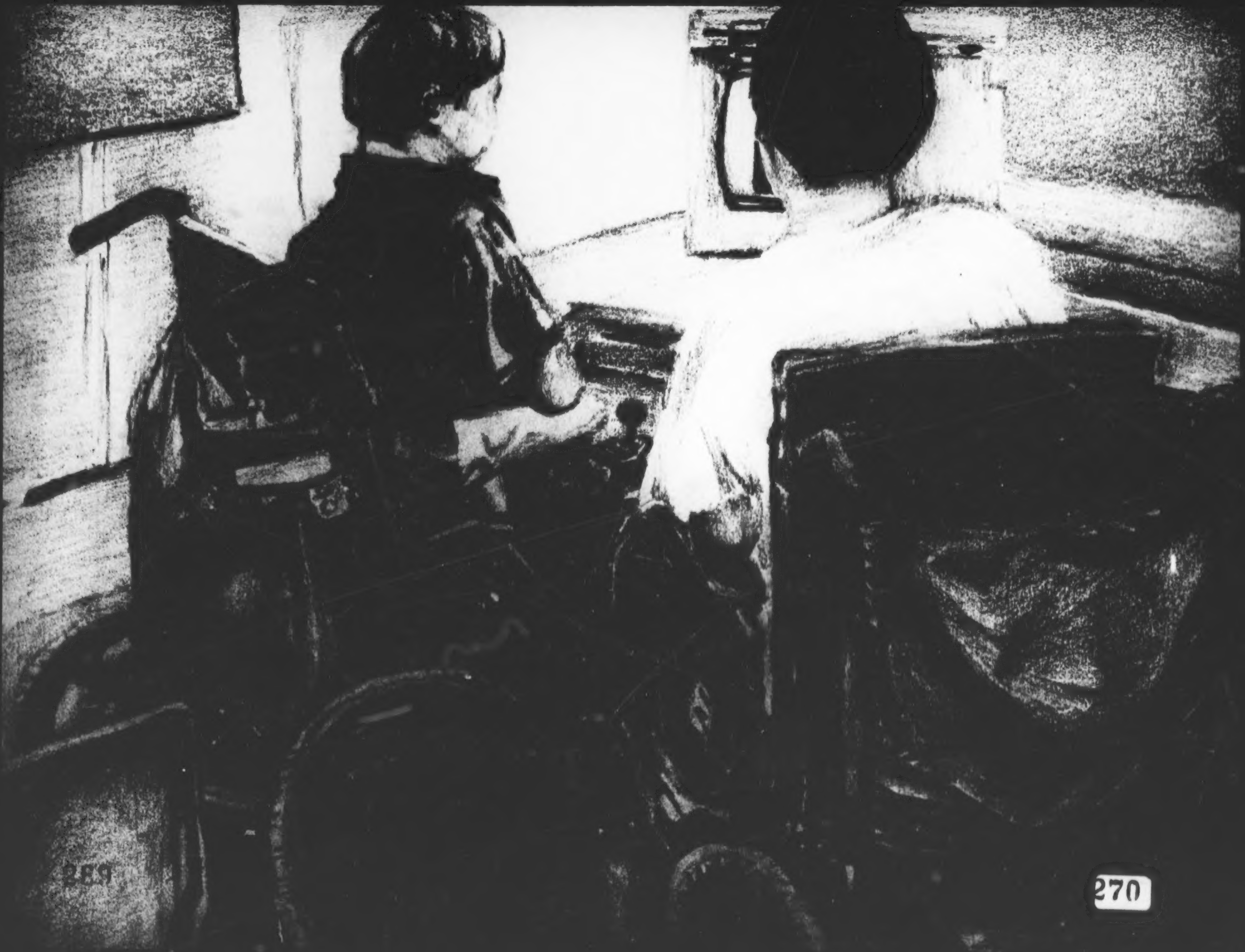
Approximate costs and materials used:

Walnut boards	45.00
20" of polyurethane roller, McMaster Carr #2292T13	92.00
2-30"x4"x1/8" aluminum plates	
108" of 1" O.D. aluminum tube w/square cross-section	
16" of 1" I.D. aluminum tube w/square cross-section	120.00
4 ladder feet, McMaster Carr #8186T16	8.00
felt, varnish, brushes	5.00
"Bunny" boots	63.00
Misc. hardware	30.00
Welding	51.00
TOTAL	**414.00**





LEFT/RIGHT SYMMETRIC
ALL DIMENSIONS IN INCHES
ROLLERS LOCATED UNDER SKIS



CHAPTER 17

UNIVERSITY OF WASHINGTON
DEPARTMENT OF ELECTRICAL ENGINEERING
SEATTLE, WASHINGTON 98195

Principal Investigator:

Yongmin Kim (206)545-2271

"Computer Input Device"
An Adaptive Device for Computer Usage By the Mentally and Physically Disabled

Designers: Dan Tran and Wai Kam

Disabled Coordinator: Dr. John Eiler of Fircrest School

Supervising Professor: Dr. Yongmin Kim

Department of Electrical Engineering
University of Washington
Seattle, WA 98195

INTRODUCTION

The Computer Input Device was designed so the computer can be easily operated by physically and mentally disabled individuals, without disrupting the operation of the normal keyboard. The Computer Input Device allows the disabled individual to use the computer by utilizing several large keys on a device situated between the keyboard and the computer.

This computer input device incorporates the following features. There are five large selection keys to communicate with the computer, the keyboard is able to communicate with the computer at all times, the selection keys are programmable, and the device is safe and easy for the student to use. The computer input device has been designed to be easy to use without requiring the user to do a lot of typing.

SUMMARY OF IMPACT

The Fircrest School in Seattle is a residential facility for the developmentally disabled. At Fircrest, there are special software programs written for the Macintosh computers that enable the handicapped students to make choice selection. The students find it difficult to operate the keyboard because of individual physical or mental disabilities. The Computer Input Device was designed to help physically and mentally handicapped students use the Macintosh computer without the difficulty associated with the regular keyboard.

The Computer Input Device (CID) is interconnected between the Macintosh keyboard and the Macintosh main unit by standard telephone RJ11 cables; the keyboard plugs into the CID and the CID plugs into the Macintosh. The CID is enclosed in a metal box with two RJ11 jack on either side. There are five 1/8" phone jacks arranged horizontally on the surface of the box for connection of a variety of switch-type input devices (large format switches are available at Fircrest School). There is also a row of five DIP switches and five buttons for programming the CID.

When no selection is made on the CID, commands from the Macintosh (sent on the bidirectional serial data line) are directly passed to the keyboard. However, when one of the buttons connected to the CID is pressed, Inquiry and Instant commands are intercepted by the CID and the assigned code for the CID input is injected into the serial data line to the Macintosh.

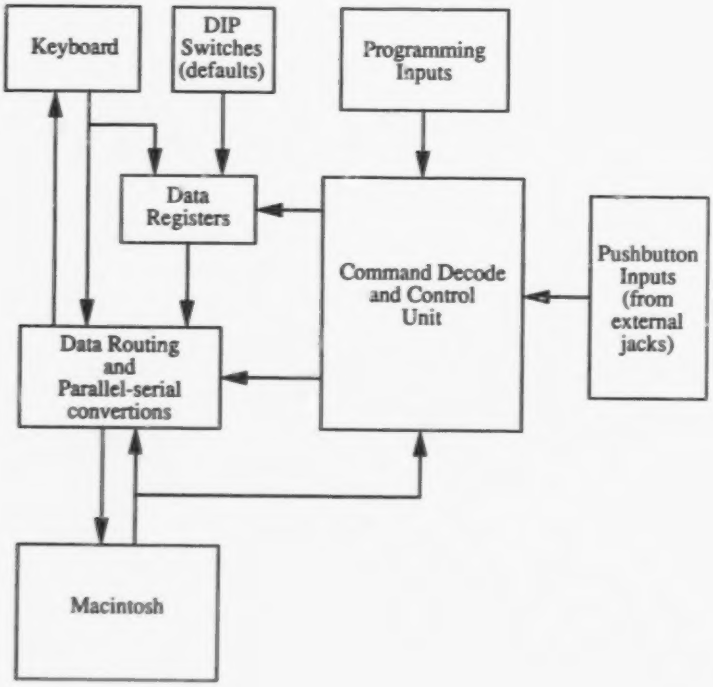
The code assigned to each of the CID button inputs are stored in five 8-bit registers. These registers are preloaded, on power up, with the DIP switch settings on the front panel of the CID. This default setting any of the five CID inputs may be overridden by pressing the corresponding programming switch and the desired key on the keyboard simultaneously. This causes the keyboard code to be loaded into the appropriate register.

The data clock signal from the keyboard is used as the system clock for the CID. Control of the data flow is maintained by a state machine implemented in a single PAL22V10.

Crosstalk and reflection problems were major sources of error in the initial prototype and the designers were required to provide termination resistors and Schmitt triggers on the data and clock lines of the RJ11 cables.

Software utilizing single keystroke inputs from disabled students was already available from Fircrest.

The approximate cost of the CID is $250. This project allows those lacking the manual dexterity to operate a keyboard needed in using the Macintosh computer.


Keyboard
DIP Switches (defaults)
Programming Inputs
Data Registers
Command Decode and Control Unit
Pushbutton Inputs (from external jacks)
Data Routing and Parallel-serial convertions
Macintosh

"Remote Controlled RF Traffic Light Controller" An Aid in Educating the Mentally or Physically Disabled in Pedestrian Safety

Designers: John Rivard and Jeff Schroeder

Disabled Coordinator: Dr. John Eiler of Fircrest School

Supervising Professor: Dr. Yongmin Kim

Department of Electrical Engineering
University of Washington
Seattle, WA 98195

INTRODUCTION

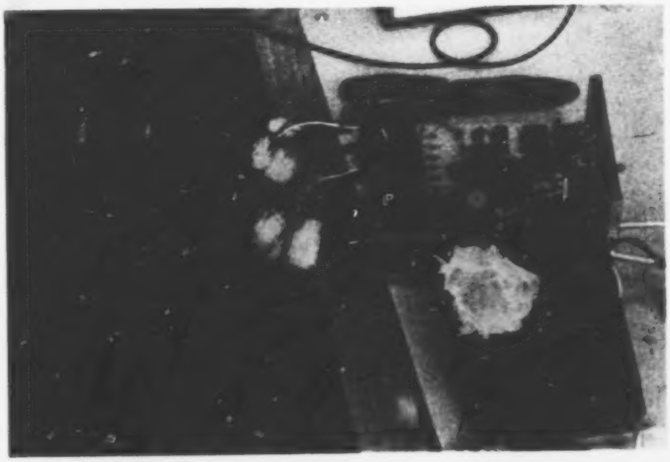
The Remote Controlled RF Traffic Light Controller is an instructional device for educating physically and mentally disabled individuals in pedestrian safety. It consists of one hand-held remote control unit and two receiver stations, each connected to a set of traffic and walk lights, to be used in a controlled environment such as a school campus. Each light station stands alone with its own power supply and receiver unit, and consists of a green-yellow-red traffic light, a walk/don't walk light, and a walk button. The intersection operates in one of two main modes, cycling or flashing.

Only two light sets and two receiver circuits were implemented in this project, but to allow for future expansion, the remote unit is able to control a full bi-directional intersection made up of four corner stations, with each station consisting of two traffic light sets and one receiver unit.

SUMMARY OF IMPACT

Fircrest School in Seattle is a residential treatment facility for the developmentally disabled, serving approximately 500 such individuals. Although most are permanent residents, some will leave the school to live on their own or in halfway houses. Fircrest has acquired two sets of traffic lights and walk signals for use in teaching clients how to obey traffic lights and to safely cross normal intersections. The goal of this project was to design and build a single remote control unit and the receiving control logic for the two sets of lights that Fircrest already has, incorporating Fircrest's specifications for the system.

For the handicapped individual to be able to live independently, either on their own or in a halfway house, basic survival skills for the city, such as pedestrian education and safety need to be mastered. The Remote Controlled RF Traffic Light Controller should be very helpful in training these handicapped individuals in a safe and familiar environment.



The Remote Control RF Traffic Light Controller (RC-RFTC) is a revised and updated design of the older "Remote Controller for Traffic Light" project.

In this improved configuration, there is a separate hand-held controller unit and stationary traffic unit. The mode of communication has been improved in both reliability and flexibility. Whereas the older project used pulse coded modulation (PCM) and the analog circuitry of a toy car, the RC-RFTC uses a walkie-talkie transmitter and receiver to transmit DTMF encoded tones. The use of monolithic DTMF encoders and decoders makes this form of communication more reliable as well as more flexible. One of sixteen different 2-tone combinations can be transmitted at a time (equivalent to 4 bits of information). Furthermore, the walkie-talkie circuits allow half duplex communication between the hand-held controller and light station; this too is an improvement over the simplex communication channel used before.

The hand-held unit front panel has five switches and 2 arrays of LEDs. The row of LEDs at the top represents the cycling of the controller through the different states. The other LED array mimics the current status of the traffic and walk lights. The toggle switches control the power and operational mode of the controller.

The controller unit broadcasts the current state to the traffic light stations. The traffic light stations respond by turning on and off the appropriate lights for the received state. In turn, each traffic light station is capable of transmitting the status of the walk button back to the controller.

An Intel 8031 microcontroller is employed in the controller unit to process the inputs and track the states. The 8031's internal timer is used to provide the timing of the state transitions. The use of a programmable microcontroller as opposed to the fixed state machine used previously, allows state durations to be varied and state transitions made more complex. Two modes of operation are currently supported: cyclic and flashing.

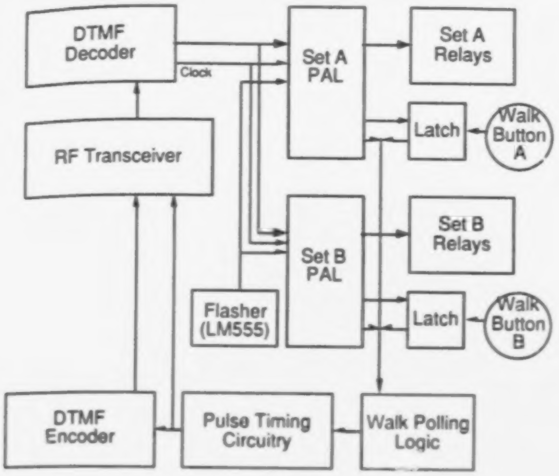
In the cyclic mode, the lights sequence through a traffic light pattern typical of a four-way intersection. The use of the walk button is optional; if not used, the walk light is programmed to come on automatically, following the lead of the traffic lights.

In the flashing mode, one direction is set to flashing red and the other to flashing yellow. This simulates a typical intersection of a side street with a minor thoroughfare.

The approximate cost of this project is $250.

RF Traffic Light Controller

Receiver Station Block Diagram and Schematic

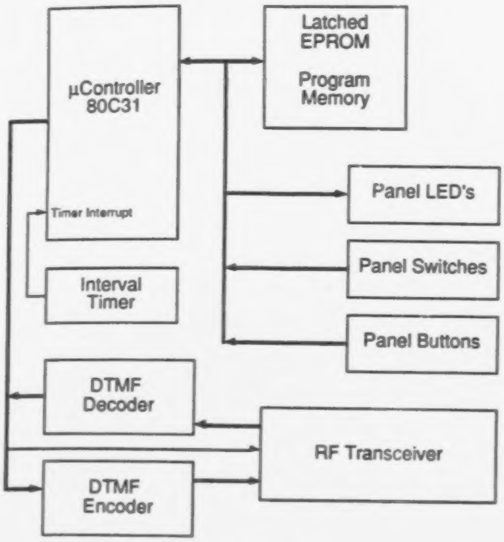


TRAFFIC LIGHT RECEIVER UNIT

Figure E: Receiver Station Block Diagram

RF Traffic Light Controller

Remote Control Unit Block Diagram and Schematic



REMOTE CONTROL UNIT

Figure D: Remote Controller Block Diagram

Receiver Station Hardware Description

Each receiver station consists of a receiver control circuit and up to two sets of orthogonally placed traffic lights. The station must be transportable for use outdoors and must not require external hookups for power. In the following sections we will discuss the packaging and power requirements of the receiver station, and will describe the remote receiver circuitry, decoding circuitry, walk button and polling circuitry, and remote transmitter circuitry of the receiver station.

Packaging and Power

Due to the size of the traffic lights themselves, the receiver station is not intended to be completely portable, though it must be transportable. In addition, the entire station must be

"Self Injurious Behavior (SIB) Data Collection Unit"
A Micro-Controller Based Device

Designers: Steven Martin and Steven Bohrer

Disabled Coordinator: Dr. John Eiler of Fircrest School

Faculty Supervisor: Dr. Yongmin Kim

Department of Electrical Engineering
University of Washington
Seattle, WA 98195

INTRODUCTION

The SIB Data Collection Unit (DCU) is a helmet-mounted microcontroller based data collection device designed to measure treatment progress for patients suffering from Self Injurious Behavior. The SIB monitor measures and records the force and frequency of a patient's self-inflicted blows to the head, which is the usual manifestation of SIB. The parameters recorded are time of day, number of blows, and force of blows.

The severity of the blows that the SIB patient typically inflicts upon himself requires that he always wear a sturdy helmet, resembling a motorcycle helmet. The battery powered DCU is imbedded in the protective foam inside the helmet. The device senses forces on the helmet by collecting analog signals proportional to the accelerations experienced by the helmet. Total data collection time can be up to four hours. The accumulated data can be downloaded to the SIB Data Storage Unit (DSU) that has been separately developed by a different team.

SUMMARY OF IMPACT

Fircrest School in Seattle is a residential treatment facility for the developmentally disabled. A number of these physically and/or mentally disabled individuals suffer from Self Injurious Behavior. The SIB Data Collection Unit can provide researchers at the Fircrest School with reliable, comprehensive data that can be easily obtained and readily downloaded to a Macintosh. The three main concerns with researchers at Fircrest are the frequency of occurrences, the force of impact, and the time of day of the occurrences. It is hoped that by analyzing the data obtained with the SIB DCU, that a Behavioral Therapist will be able to determine treatment progress in reducing not only the frequency, but also the force of the blows a SIB patient endures.

The SIB DCU is based on the Motorola MC68705G2 microcontroller with onboard 2K ERPOM. The four 8-bit I/O ports are assigned as follows: 2 ports to interface to the 32K x 8 SRAM used for data storage, 1 port for data transfer (to the SIB Data Storage Unit, DSU) and 1 port for control signals.

To detect the rapid accelerations and decelerations associated with violent head movement, two commercial accelerometers are orthogonally mounted within the helmet. The accelerometers which consist of strain gauges in a Wheatstone Bridge configuration produce differential voltages as it undergoes stresses due to acceleration.

The output of the accelerometers from a typical blow to the helmet resembles a exponentially decaying sinusoid. This differential signal is amplified using an instrumentation amplifier which converts the signal to a single-ended output, provides signal gain and offset adjust. The following analog stage rectifies the bipolar signal. Finally, just prior to digitization, the signal is fed into a peak and hold circuit to capture the maximum acceleration.

The conditioned accelerometer signals are digitized using a successive approximation 8-bit A/D converter. The A/D converter is activated under microcontroller direction.

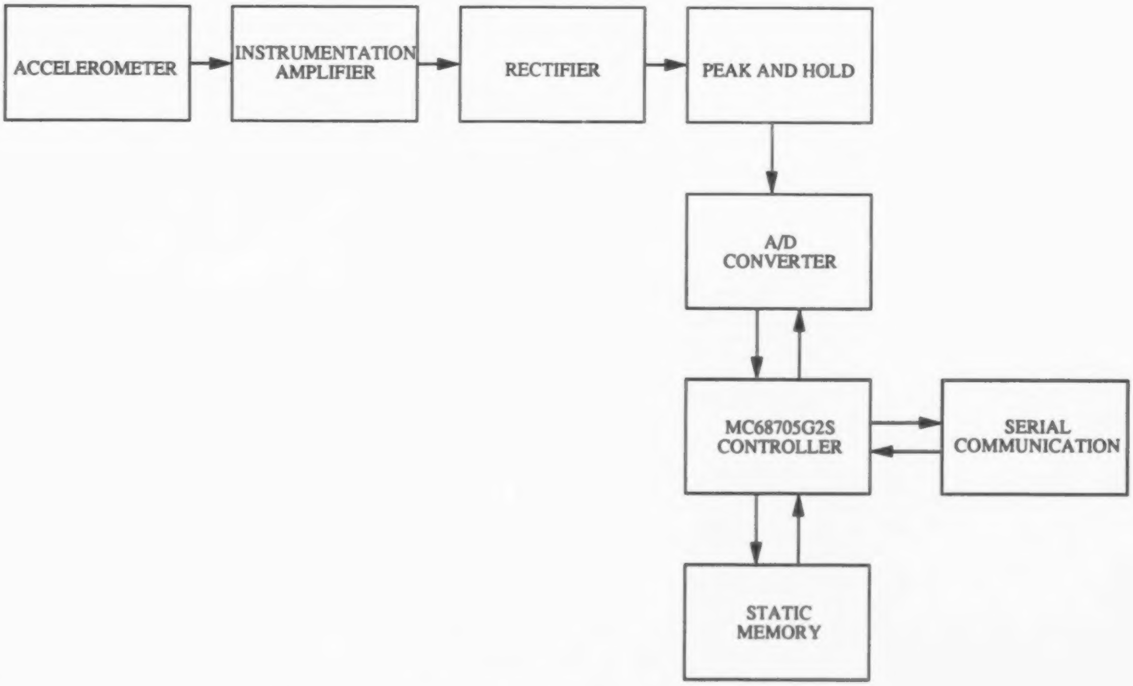
A data communication channel to the Data Storage Unit (DSU) is provided by a USART and an RS-232 compatible port. The DCU resets, changes data threshold, collects data and downloads data under the direction of the DSU.

The microcontroller runs in the power saving Wait mode between data collection intervals. When the microcontroller's built-in timer generates an interrupt, the processor reads the accelerometer values, calculates the magnitude of the resultant force vector, storse the data in SRAM, and checks for commands from the DSU in the USART. If a command is detected in the USART, a software interrupt is generated so that the proper action can be taken.

Since the accelerometers are mounted orthogonally, the magnitude of the resultant force vector is easily computed as the square root of the sum of the squares of each of the accelerometer values. To reduce the computational overhead, the square root was implemented using a lookup table technique.

The actual force magnitude value is not directly stored. Rather, 120 different histograms representing the number of blows in each of 256 different force ranges over a period of 2 minutes is stored. With the 32 K x 8 memory of the DCU, there is enough data storage for 4 hours of data collection.

The approximate cost of the project is $350.



"Self Injurious Behavior (S.I.B.) Monitor"
A Data Storage Unit

Designers: Rochelle Mai and John Ogden

Disabled Coordinator: Dr. John Eiler of Fircrest School

Supervising Professor: Dr. Yongmin Kim

Department of Electrical Engineering
University of Washington
Seattle, WA 98195

INTRODUCTION

The SIB Monitor is an automated data collection tool designed to measure treatment progress for patients suffering from Self Injurious Behavior. The SIB monitor measures and records the force and frequency of a patient's self-inflicted blows to the head, which is the usual manifestation of SIB. The monitor output can be downloaded to a Macintosh computer for analysis by a Behavioral Therapist.

The SIB Monitor consists of two modules: A Data Collection unit (DCU) and a separate Data Storage Unit (DSU). The severity of the blows that the SIB patient typically inflicts upon himself requires that he always wear a sturdy helmet. The DCU is mounted inside this helmet to measure and store impact data for four hour periods. The DSU provides bulk data storage of the data accumulated by the DCU. When full, the DSU provides for serial download to a Macintosh computer for analysis by the therapist. The two module design provides the best compromise for providing high storage capability and meeting the size and power constraints of the helmet.

SUMMARY OF IMPACT

Fircrest School in Seattle is a residential treatment facility for the developmentally disabled. A number of these physically and/or mentally disabled individuals suffer from Self Injurious Behavior (SIB). SIB can vary widely in severity, but at its most extreme, it can cause extensive tissue and sensory damage, and is extremely difficult to treat. A problematic issue in alleviating SIB has been measurements of treatment progress. It is hoped that by analyzing the data obtained with the SIB monitor, that a Behavioral Therapist will be able to determine treatment progress, reducing not only the frequency, but also the force of the blows a SIB patient endures.

The DSU is housed in a 10" x 6" x 2" metal enclosure. Mounted on the upper surface are an LCD display and two toggle keyswitches. Mounted on the side is an RS-232 compatible cable and connector.

The DSU design centers around its Motorola MC68705G2 microcontroller. This processor features built-in 2K EPROM, 112 bytes of RAM, 32 I/O lines (organized as 4 8-bit ports), on-board timer and interrupts.

The four I/O ports are used for the address bus, the data bus, control signals, and the key input bus.

The specification called for the DSU to support a memory size of 256 Kbytes (equivalent to store 8 downloads from the DCU). However, the microcontroller can only access 64 Kbyte. To expand the memory range, a 24-bit memory address register formed by 3 8-bit registers is provided to interface to the data storage memory. This provides a maximum addressing capability of 16 Mbytes.

Besides the memory system, three other types of devices are interfaced to the microcontroller: the LCD display, the keyswitches and the USART.

The 16 x 1 character LCD display is used to provide an interactive interface to the user. One of the keyswitches, labeled "Select", is used to scroll through the different DSU operations. The other switch, labeled "Up/Down", is used to select the value or setting for each option.

The USART allows data to be downloaded from the DCU or uploaded to a host computer. RS-232 drivers and receivers translate the TTL signal levels of the USART to and from RS-232 levels.

The DCU does not directly store actual force magnitude values. Rather, 120 different histograms representing the number of blows in each of 256 different force ranges over a period of 2 minutes is stored. With the 32 K x 8 memory of the DCU, there is enough data storage for 4 hours of data collection.

The DSU's 256 Kbyte memory allows up to 8 downloads of DCU memory or 32 hours worth of data collection. However, due to the exorbitantly high prices of memory at the time of this project, only 32 Kbytes of SRAM is currently installed.

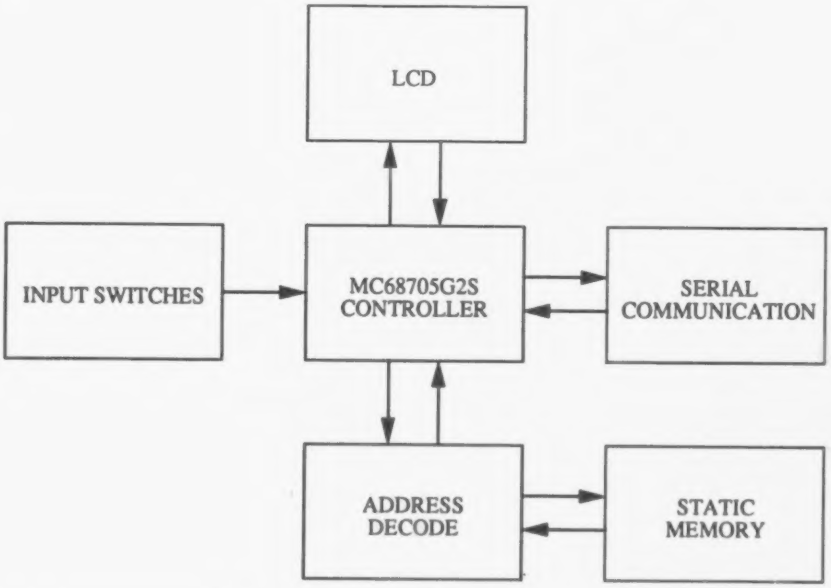
The processor normally runs in the power saving Wait mode. However, when an interrupt is received from the keyswitches, the processor becomes active and enters its interrupt service routine (ISR). Currently supported operations are: DCU Download, DCU Diagnostics and Computer Upload.

In DCU Download mode, the download command word ($55) is sent to the DCU. The DCU responds by sending its status code (including the number of histogram records accumulated so far) followed by the existing data.

DCU diagnostics allows the user to set the DCU threshold value and check the amount of remaining DSU memory. If the DCU threshold is changed, the DCU threshold command ($02) is sent followed by the new threshold value.

The Computer Upload function sends all the histogram records in memory to the host computer connected to the RS-232 cable. The data is first converted to decimal ASCII characters and delimited by commas before transmission. Further, a carriage return and line feed is inserted after every 16 histograms of data.

The approximate cost of the DSU is $300.



"Vocational Production Monitor"
A System for Monitoring the Productivity of Mentally and Physically Disabled Workers

Designers: Meng Chao and Khai Trinh

Disabled Coordinator: Dr. John Eiler of Fircrest School

Supervising Professor: Dr. Yongmin Kim

Department of Electrical Engineering
University of Washington
Seattle, WA 98195

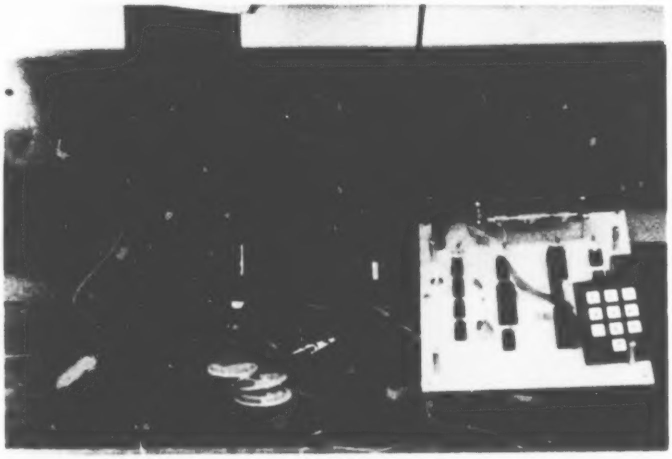
INTRODUCTION

The Vocational Production Moniotor (VocMon) system monitors the production rate of physically and/or mentally disabled students in a sheltered workshop setting. The VocMon counts the items each student produces and generates a signal to produce a reward when a certain threshold is reached. The type of reinforcement is determined by the student supervisor. Any device such as a radio or recording which may be switched on by a relay, may be used as a reinforcer.

The VocMon can display the production rate (PR), the total elapsed time (TET), the total time (TWT) and the total reinforcement duration (TRD). In addition, it is programmable. It allows the instructor or supervisory personnel to easily change the default reinforcement duration. The VocMon is made up of two separate units, the Sensor unit and the Data Collector (microcontrol) unit. The microcontrol unit is capable of accepting data from four different sensor units and calculating the production rate of each.

SUMMARY OF IMPACT

The VocMon system was first conceived at the Fircrest School in Seattle, which is a residential treatment facility for the developmentally disabled. The VocMon system monitors the productivity level of such handicapped individuals in a sheltered workshop situation. The VocMon system can be helpful in raising the productivity levels of handicapped workers by providing tangible rewards for greater efficiency.



The VocMon design centers around the Intel 8031 8-bit microcontroller. The main unit consists of the microcontroller, support chips (EPROM, latches, etc.), an 16 x 1 LCD display and a 3 x 4 numeric keypad. The each sensor unit is enclosed within a 1 ft high, 5 inch diameter PVC pipe. The sensors are an infrared emitter/detector pair mounted across from each other on the circumference of the pipe. Digital outputs are provided to control external electrical devices used as reinforcers. A single VocMon unit can accomodate up to four sensors and four individually controlled reinforcers.

The IR emitter is pulsed by the microcontroller. The IR detector output is amplified, filtered and transmitted to the microcontroller. If an object is dropped into the pipe it interrupts the IR signal and the expected pulse pattern is not received by the IR detector.

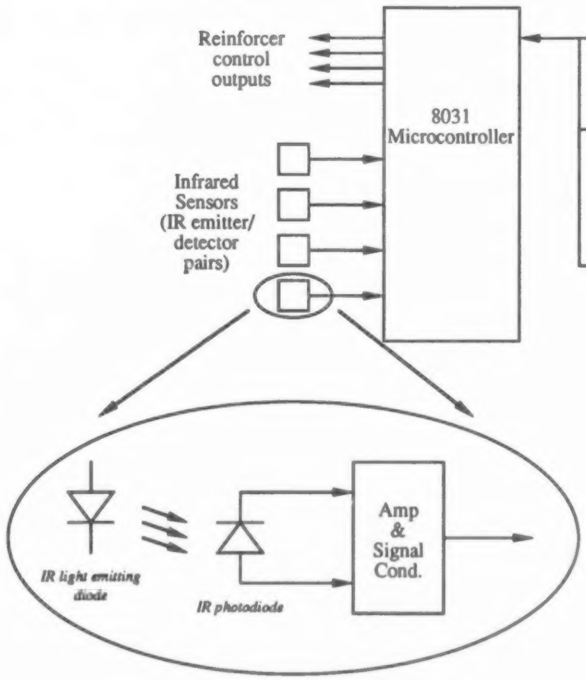
The LCD is interfaced to one of the microsontroller's I/O ports. Another port is used by the sensors and reinforcer outputs. Another is used to connect to an Intel 8255 Parallel Input/Output (PIO) chip to expand the number of control ports. Currently, the PIO is used just to interface to the keypad.

The keypad is decoded using a row scanning technique. Using the row lines coming out of PIO, each row of the keyboard row is strobed sequentially with a low pulse. If a key is pressed in a row, the low pulse is transferred to a column input on the PIO. The combination of row and column uniquely identifies the key.

The built-in timer of the microcontroller is used to time reinforcer activation, find total elapsed time, find total work time and to calculate production rates.

The software allows changing parameters such as the threshold production rate for reinforcer activation and the reinforcer duration.

The approximate cost of the VocMon and a single sensor unit is $200.


Reinforcer control outputs
8031 Microcontroller
EPROM (8K x 8)
LCD (20 x 2 char)
row strobes
8255
Keypad
column inputs
Infrared Sensors (IR emitter/ detector pairs)
Amp & Signal Cond.
IR light emitting diode
IR photodiode

"Choice Selection System"
A Training System for Nonverbal Disabled Individuals

Designers: Roman Mach and John Gilbert

Disabled Coordinator: Dr. John Eiler of Fircrest School

Supervising Professor: Dr. Yongmin Kim

Department of Electrical Engineering
University of Washington
Seattle, WA 98195

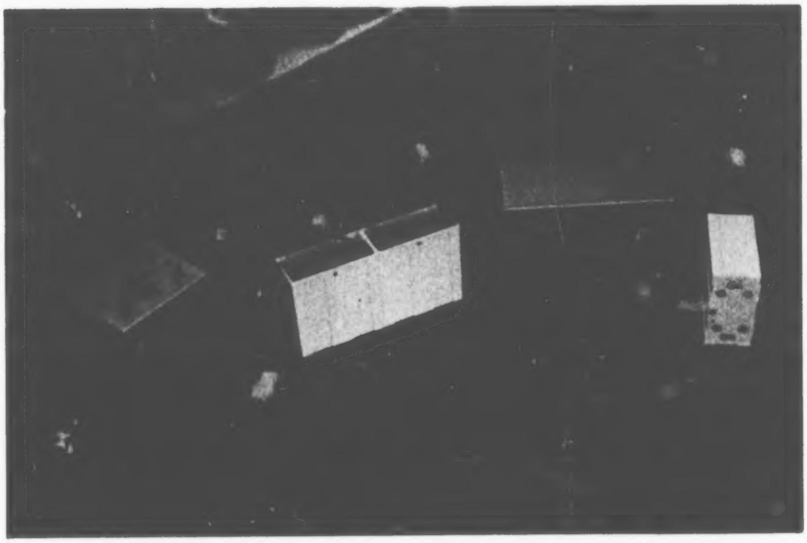
INTRODUCTION

The Choice Selection System, which is designed for the Fircrest School in Seattle, allows nonverbal students to make structured choice selections from visual cues. The student chooses from a linear array of three to six Choice Selection Modules (CSM). Each CSM holds some visual stimulus that represents a distinct choice available to the user. Each CSM has a light source, which is lit in turn. During this illumination, a switch closure will result in a speech segment being produced, corresponding to the picture on the illuminated CSM. Pictures indicating available choices can be readily attached to the display and the scan rate among the multiple CSM's is easily adjustable.

A series of CSM's is controlled by a Digital-to-Analog/Controller Module (DAC), or a Programming Module (PRM). The DAC allows playback of the digitized sound, and is intended for use by a student. The PRM allows digitizing and playback, and is intended for use by a therapist or other supervisory personnel for programming of the choices.

SUMMARY OF IMPACT

The Fircrest School in Seattle is a residential facility for developmentally disabled individuals, some of whom are nonverbal. The Choice Selection System allows these nonverbal students to vocalize their desires via the CSM modules' prerecorded messages. It could benefit them by providing the ability to make structured choice selections to indicate basic wants and needs, for example, desired foods from a menu, preferred leisure or educational activities or daily clothing selections.



The CSM's and the DAC, or PRM, are interconnected using a five-ine bus plus a daisy-chained CASCADE line to pass control from module to module.

The five-line bus includes two lines for power and ground, a clock line to synchronize the CSM's with either the DAC or PRM, a bidirectional data line for a digitized audio signal and a control line for command transmission to the CSM's.

The CASCADE line is interconnected between the CASCADE IN and CASCADE OUT inputs (outputs) of adjacent units. It is used to pass a single bit token. When a CSM receives the token at its CASCADE IN input, then a communication link (for data and commands) is established between the CSM and the DAC (or PRM). An LED on the CSM case is illuminated to indicate that this is the active module. This protocol is maintained by identical state machines in each module.

Commands are sent over the CONTROL lines as varying length pulses of 1 to 4 clock pulses. By enabling a counter for the duration of the CONTROL pulse, the value that remains in the counter is the 2-bit instruction code. Commands are ADVANCE (DWELL), RECORD, PLAYBACK and RESET.

The design of the PRM and DAC modules is nearly identical and differs only in the PRM's ability to record (digitize) sound. In fact, the same printed circuit board layout is used for both modules.

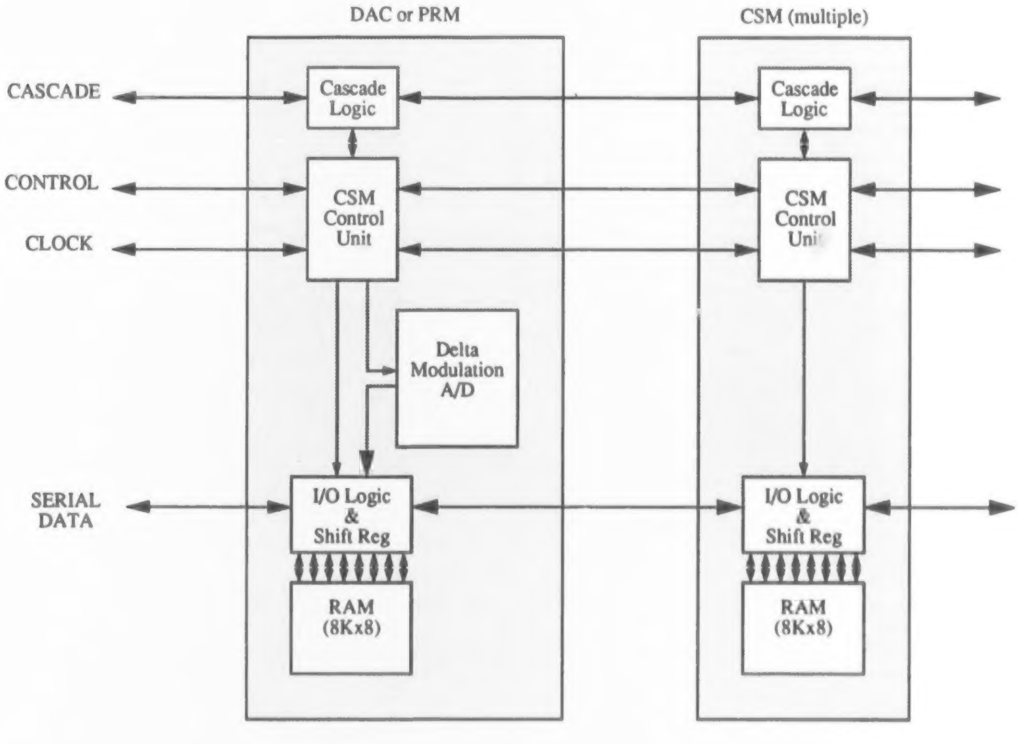
The method of digitization chosen is Continuously Variable Slope Delta (CVSD) Modulation or Delta Modulation. The Motorola MC3417 CVSD modulator/demodulator serves as both the A/D converter and D/A converter for the system. It is operated at a 16 KHz sampling rate.

For RECORD operations, the serial data stream from the CVSD chip is transmitted by the PRG to the CSM over the DATA line. Once in the CSM, it is shifted into an 8-bit CMOS shift register and stored in an 8K x 8 SRAM. The process is reversed for PLAYBACK.

The audio output from the CVSD converter is lowpass filtered by a two-pole Butterworth 1461 Hz active filter and a single pole Butterworth 2040 Hz active filter. This combination was experimentally determined to give the best overall playback sound quality.

The input signal to the CVSD converter is bandlimited to 15 - 2040 Hz by a three-pole bandpass filter (cascaded Butterworth lowpass and highpass filters).

The approximate cost of this project, which includes one DAC, one PRM and two CSM's, is $740. $250 each for the DAC and PRM and $120 each for the CSM's.



"Calculator for the Handicapped"
An Input Calculator For the Physically Disabled

Designers: Patrick Phung, John White and Glenn Yu

Disabled Coordinator: Mr. Al Ross

Supervising Professor: Dr. Yongmin Kim

Department of Electrical Engineering
University of Washington
Seattle, WA 98195

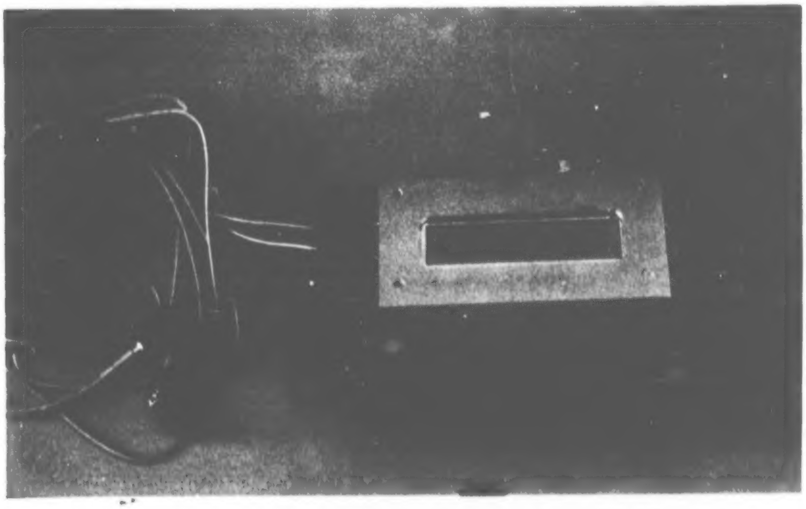
INTRODUCTION

The Calculator for the Handicapped has been designed to allow physically and/or mentally disabled persons to control the operation of a calculator using only one or two switches which they can easily control. Two modes of operation are supported. In the single switch mode, the LCD will display all the digits and the mathematical operations available to the user on the screen. A cursor will scroll automatically through the digits and the operations one at a time, and the scrolling rate can be varied through a variable switch on the calculator. If the user wants to choose a digit or operation, he or she hits the switch when the cursor reaches the desired location. In the double switch mode, the user has more control over the selection process, and the selection (digit or operation) can be entered in Morse Code, since the switch can be decoded as dots or dashes. In both modes, the input selections and results of the calculations are displayed on the LCD.

The calculator is designed to be as small as possible so it will not obstruct the user's vision and movement. The casing is free of sharp edges to prevent the user from any potential injuries and it has self-contained batteries. Three forms of power supply provide portability and long-term use: battery power, wheelchair battery power, or power from a standard AC outlet.

SUMMARY OF IMPACT

Due to the limited controlled movements of a handicapped person, such an individual is not able to use the standard calculators that are widely available commercially. Since many handicapped people are more mobile because of govenmental support and public awareness, and many are living independently or in halfway houses, they are starting to need and desire such conveniences as a calculator. Not only can a calculator be an aid in budgeting, for example, on shopping excursions, it can be very helpful for those handicapped individuals whose motor control is such that holding a pen or pencil is problematic.



Externally, the calculator is extremely simple. The only visible external features on the 6" x 3-1/2" x 2" black metal enclosure are a 20 x 2 LCD display, two dials, a DC power jack, two switch input jacks and three switches.

Inside the calculator is an Intel 8031 microcontroller which provides the computational power as well as overall system control.

The LCD display is memory mapped into the 8031's address space. Scroll rate is determined by a potentiometer whose output is digitized by an 8-bit A/D converter. The digitized value is used by the microcontroller to control the scroll rate of the LCD display.

The handicapped user provides input to the calculator by using head switches (or some other type of momentary contact switch) connected to the switch input jacks. These switches are debounced using an RC circuit and Schmitt triggers. The debounced signals are connected directly to the 8031's interrupt inputs.

Power can be supplied either from internal NiCad batteries or from an external voltage regulator connected to the DC power jack. A battery charging circuit was incorporated so that the DC power jack can also be used to recharge the NiCad batteries.

To conserve power and make it easier for a physically handicapped person to activate the calculator, a special on/off circuit is incorporated into this device. When either input switch is depressed, power flows to the microcontroller long enough for it to start up and activate a relay which will channel power into the circuit on a more permanent basis. Since the relay is under the microcontroller's control, power can be turned off under software control as well as manually by the user.

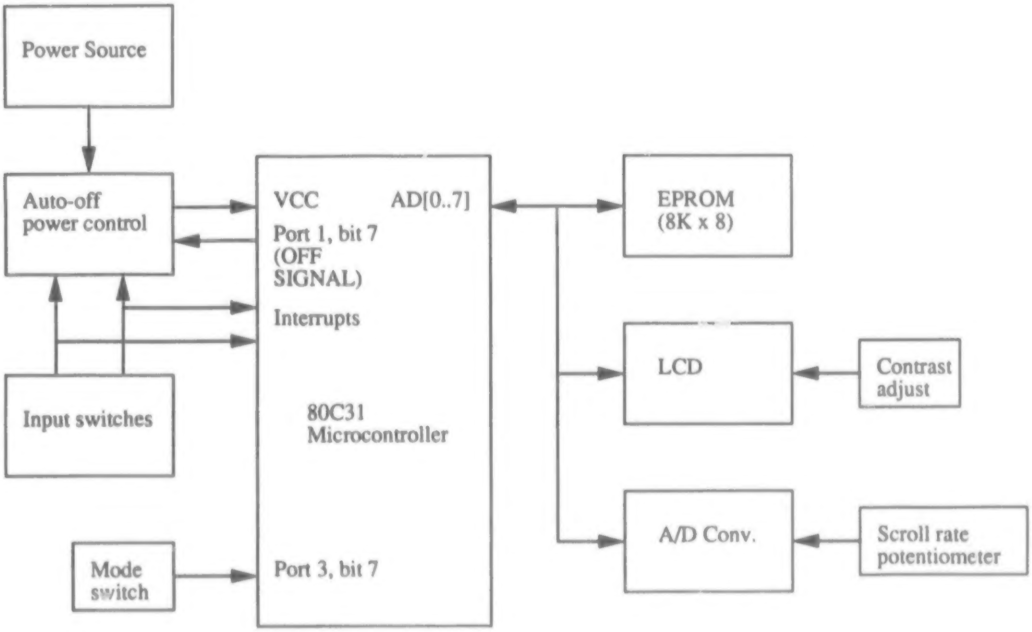
There are two operational modes which the software supports: scrolling (single button) and Morse Code (two buttons).

In the former mode, the 8031 causes the cursor to constantly scroll through all the possible inputs (digits, operators, and editing functions) at the rate set by the scroll rate dial. When the headswitch is pressed, calculator accepts as input whatever is currently at the cursor. In the latter mode, the user uses Morse code to provide input to the calculator. In this mode, one headswitch represents dot and the other dash.

In both modes of operation, the calculator uses Reverse Polish Notation since it minimizes the number of keystrokes needed to make a calculation.

All of the arithmetic operations are done in floating point using a slightly modified floating point package obtained from Intel for the 8031 microcontroller.

The approximate cost of the calculator is $250 (not including the headswitches).



"Data Acquisition System (DAS) for Use in Prosthetic Adjustment"
A Portable Visual Display Unit for Recording Data

Designers: Will R. Cummings and Shahram Rezaimiri

Disabled Coordinator: Ms. Joan Sanders

Supervising Professor: Dr. Yongmin Kim

Department of Electrical Engineering
University of Washington
Seattle, WA 98195

INTRODUCTION

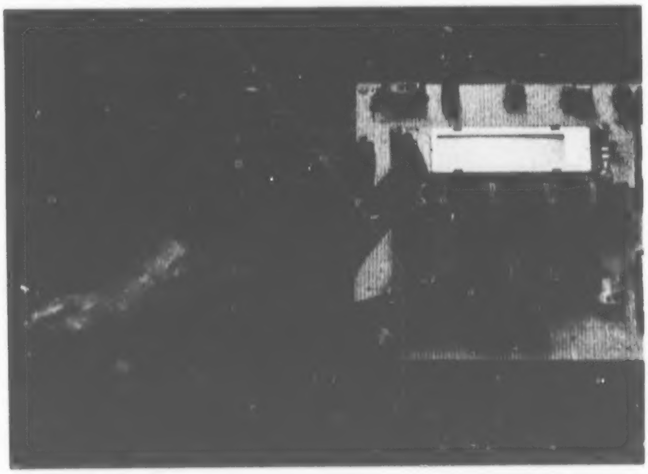
A common rehabilitation treatment for below-knee amputation is the use of a prosthetic leg. The Seattle Foot, developed by Veterans Administration and the University of Washington, is one of these prosthetic legs available. The prosthesis consists of a socket, shank, and foot. During prosthetic fitting sessions, the relative positions of these three components must be established to help achieve a stable gait and maximize comfort for the amputee. Usually this is accomplished during a succession of fittings with fitting judgement based on the prosthetist's visual observations, clinical experience, and patient feedback.

Recently, the instrumentation was developed to record the axial force, bending, and torsional movements in the prosthetic shank of the Seattle Foot during ambulation. This adds a quantitative tool that can help the prosthetist improve effectiveness and efficiency in the fitting process.

However, the current computer-based data collection system is not portable and requires the use of a 15 meter instrumentation cable. The Data Acquisition System (DAS) is a portable visual display unit for recording shank bending data. The DAS is a microcontroller-based device which records and displays amplified analog signals emanating from strain gauges bonded to the prosthetic shank, and could be carried by the prosthetist while walking with the amputee without the cable during the fitting session.

SUMMARY OF IMPACT

For the below-the-knee amputee, the use of a prosthetic leg is a main key in returning to a normal life and mobility. Accuracy of fitting of the prosthesis is of prime importance in achieving a stable gait and maximizing comfort for the amputee. The Data Acquisition System for use in prosthetic adjustment can increase the accuracy of the fitting, while eliminating any interference from a long instrumentation cable during the fitting.



This data acquisition and display system (DAS) is relatively simple. It consists of a microcontroller, EPROM, SRAM, A/D converter, LCD display and a few buttons.

The signal from the strain gauges in the prosthetic device are amplified and filtered externally before entering the DAS. The signal received by the DAS from the prosthetic device has a bandwidth of DC to 30 Hz.

Within the DAS, the Intel 8031 microcontroller activates the 8-bit A/D converter at 170 Hz and stores the captured data in the 8K x 8 SRAM. Currently, only 1600 bytes of data are stored for each sampling period. This is roughly equivalent to 10 seconds worth of data. The input range of the A/D converter is 0 to +5 volts.

A 1 second window of the captured data is displayed on the 160 x 32 dot matrix LCD module. The internal display memory is addressable from outside the LCD module in 8 pixel blocks. The software supports horizontal scrolling of the display by transferring differnt sections of SRAM memory into the display memory. This allows the user to review the entire 10 second sample within a scrolling 1 second window. The software also supports adjustment of the displayed (vertical) voltage range.

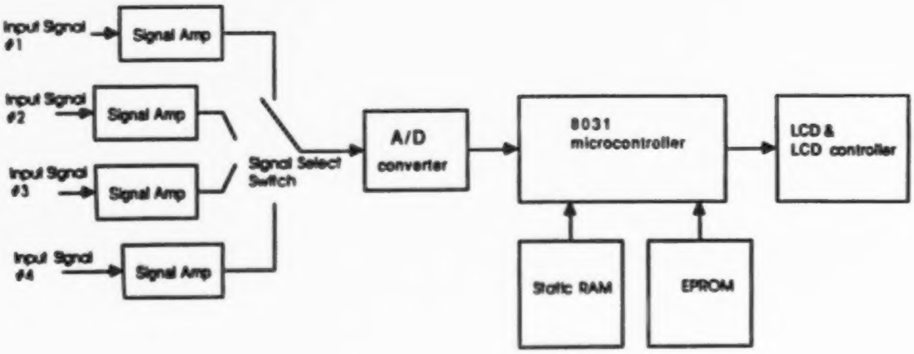
More advanced post-processing features such as measurement cursors are not difficult to add, but unnecessary for DAS's intended application--a portable field unit for prosthetic adjustment.

Pushbutton inputs are read as polled interrupt lines through the 8031's two interrupt inputs.

All external devices (EPROM, LCD display and A/D converter) are memory mapped within the microcontroller's external memory address space.

The approximate cost of this project is $250.

Block Diagram


Input Signal #1
Input Signal #2
Input Signal #3
Input Signal #4
Signal Amp
Signal Amp
Signal Amp
Signal Amp
Signal Select Switch
A/D converter
8031 microcontroller
LCD & LCD controller
Static RAM
EPROM

"Multiple Input/Output Module (MIMO)"
A Microswitch/Reinforcer Training Module for the Handicapped

Designers: Chi-Shung Wang and Vincent Chung

Disabled Coordinator: Dr. John Eiler of Fircrest School

Supervising Professor: Dr. Yongmin Kim

Department of Electrical Engineering
University of Washington
Seattle, WA 98195

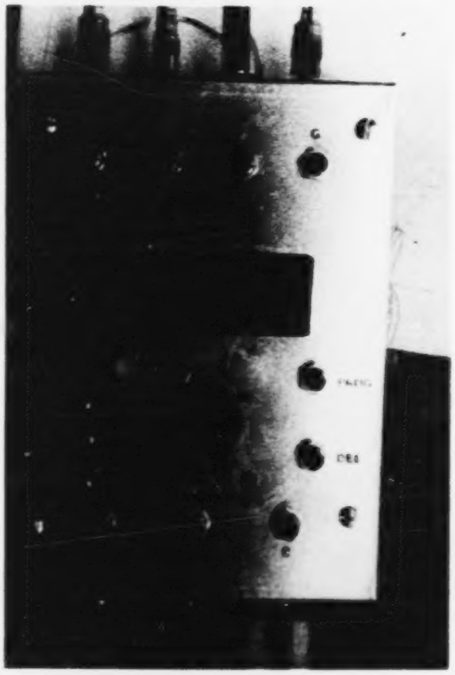
INTRODUCTION

The purpose of the Multiple Input/Output Module (MIMO) is to teach handicapped children social interaction skills and increase their capability of handling a more complex environment. A MIMO is needed in order to simplify the task of the teachers. The MIMO is actually an interface module between the user(s) and the reinforcers. There are three input keypads (A, B, and C) used by the students and four reinforcers (W, X, Y, and Z) connected to the module. The teachers can set different combinations or sequences of inputs to activate a particular reinforcer. The students, by cooperating to provide the correct inputs, can turn on one or more reinforcers (toy, TV, etc.).

During normal operation, the module has two modes, the chord mode and the sequential mode. In the chord mode, the students are required to press a combination of keys (using the keypads or the push buttons A, B, and C). If the response is correct, one or more reinforcers will be turned on with a certain time interval. In the sequential training mode, the students are required to respond to an instruction by pressing a sequence of keys with a time constraint between each key press. The time constraint is set up by the user during the time of programming. If the response is correct and within the time constraint, the device corresponding to this sequence will be turned on as a reinforcer for a certain time interval.

SUMMARY OF IMPACT

The Multiple Input/Output Module (MIMO) was designed to teach handicapped children social interaction skills and to aid their capability of handling an increasingly complex environment. A MIMO is needed in order to simplify the task of the teachers. The teacher can easily reconfigure which input controls which output as well as input/output combinations. The MIMO can provide positive reinforcement, through which the child can learn cause and effect, and increase his ability to gain control over his environment.



The MIMO box includes four 1/4" phono output jacks at the upper edge for connection of the reinforcers. Just below the jacks are the reinforcer programming buttons. At the lower edge are three more 1/4" phono jacks for connection of the input switches. Mounted just above are the input programming buttons.

The most prominent feature of the box is the 16 character by 1 line LCD display just below the reinforcer programming buttons. Below the display are the power switch, chord/sequential mode select switch, program and delete buttons and two dials which set the time that reinforcers will remain on.

The design of MIMO is centered around the Motorola MC68705U3 microcontroller. The microcontroller's four control ports, built-in timer and memory greatly simplified the hardware design.

Two of the control ports on the microcontroller are used to interface to the LCD display and to control the Relay Driving Unit of the reinforcer outputs. The remaining two ports are used to monitor the status of the various switches, buttons and dials.

The Relay Driving Unit consists of four NPN transistors which provide the coil current required by the relays. A parallel capacitor and resistor combination connect the transistor emitter to ground. When the transistor is turned on, the capacitor is momentarily shorted, causing a current surge that causes the relay to switch. After the capacitor has charged, the parallel resistor limits the circuit to the minimum holding current for the relay.

While the MIMO may be programmed using the panel switches and buttons, an RS-232 interface is also included to allow downloading of often used configurations. This greatly simplifies the programming task for the teacher. One of the microcontroller's interrupt lines is connected to the RxD line so that an interrupt is generated when data is received.

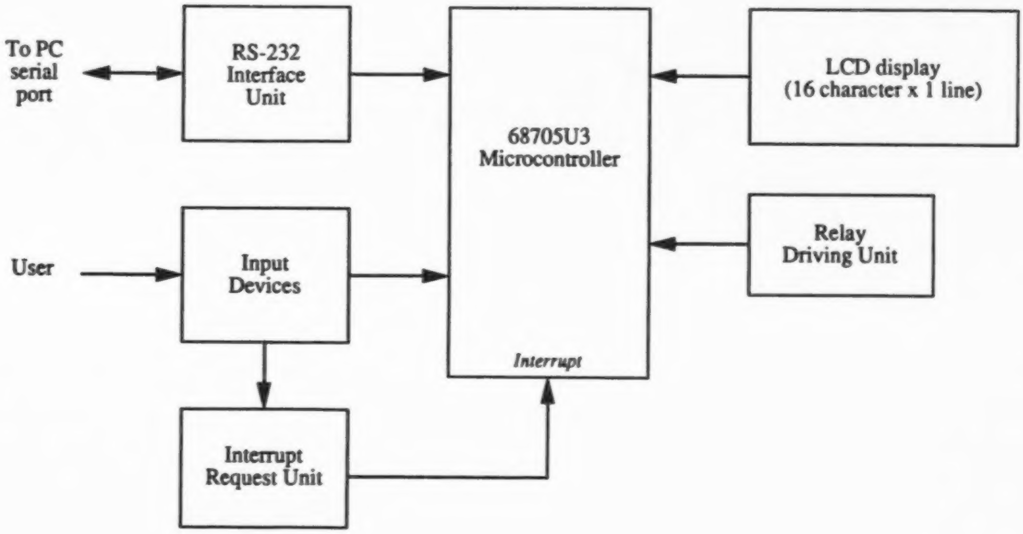
As mentioned before, two dials on the MIMO's control panel set the time delay that the reinforcers will remain on. The timing control that makes this possible is provided by the microcontroller's built-in timer.

The microcontroller's other interrupt line is used to detect when any of the MIMO's buttons are pressed (including the external input switches which connect through the front panel phono jacks). All of the debounced button signals are combined together in the Interrupt Request Unit which generates the interrupt signal.

The software architecture is organized as a single main loop and two Interrupt Service Routines (ISR). The main loop monitors the status of reinforcer delay time dials and updates the LCD display.

One of the ISRs handles the configuration download protocol when data is sent over the RS-232 port. A user-friendly download program has been implemented for IBM-compatibles running MS-DOS. The other ISR controls the manual front panel programming and the monitoring of user inputs.

The approximate cost of MIMO is $300.



"Macintosh Touch Screen"
A Computer Input Device for the Physically and Mentally Disabled

Designer: David Wu

Disabled Coordinator: Dr. John Eiler of Fircrest School

Supervising Professor: Dr. Yongmin Kim

Department of Electrical Engineering
University of Washington
Seattle, WA 98195

INTRODUCTION

The purpose of the Macintosh Touch Screen project is to make the touch screen a usable input device for particular software programs written in Pascal and presently used by the Fircrest School in Seattle, a residential school for the developmentally disabled. Computer touch screens are most useful where flexible user input such as typing is needed but is impractical due to the user's physical or mental handicap, or developmental skill level (primary education). Existing alternative input methods include the mouse, joystick, touch tablet, and touch screen. It was Fircrest's suggestion that we develop the touch screen as a viable alternate input device for use with their software. The touch screen chosen for this project is the Elegraphics DuraTouch resistive touch screen.

SUMMARY OF IMPACT

Computers can be an effective learning and positive reinforcement tool for the physically and mentally handicapped. Touch screens provide a more intuitive and directly associative method of input than more conventional devices. A user can point with a finger directly at an image instead of using an intermediate device with which he must associate a screen image. In cases where the user's mental development is not at the level necessary for indirect association, direct touch of the computer screen may be the only viable alternative. Physically and mentally handicapped individuals should find using the Macintosh Touch Screen much more straightforward than using an indirect input device such as a mouse.

The essence of the Macintosh Touch Screen project is the careful selection of an appropriate touch screen device and the creation of a software library to communicate with the touch screen.

The Elographics DuraTouch resistive touch screen was chosen both for its low cost and the availability of a RS-232 compatible controller manufactured by Elographics. The controller is interfaced to the Macintosh through its RS-422 modem port. Since RS-422 uses differential signals, it was necessary to ground the positive side of each RS-422 receiver effectively transforming the serial modem port to the RS-423 standard (which is compatible with RS-232 devices at distances of up to 50 feet away).

Power for the controller and touch screen are tapped off of the Macintosh's external drive port.

The software routines are implemented as a Turbo Pascal 1.1 library. There are currently five routines in the library: *InitSer*, *CalibrateTS*, *CheckSerPort*, *FlushSerBuf* and *GetTouch*.

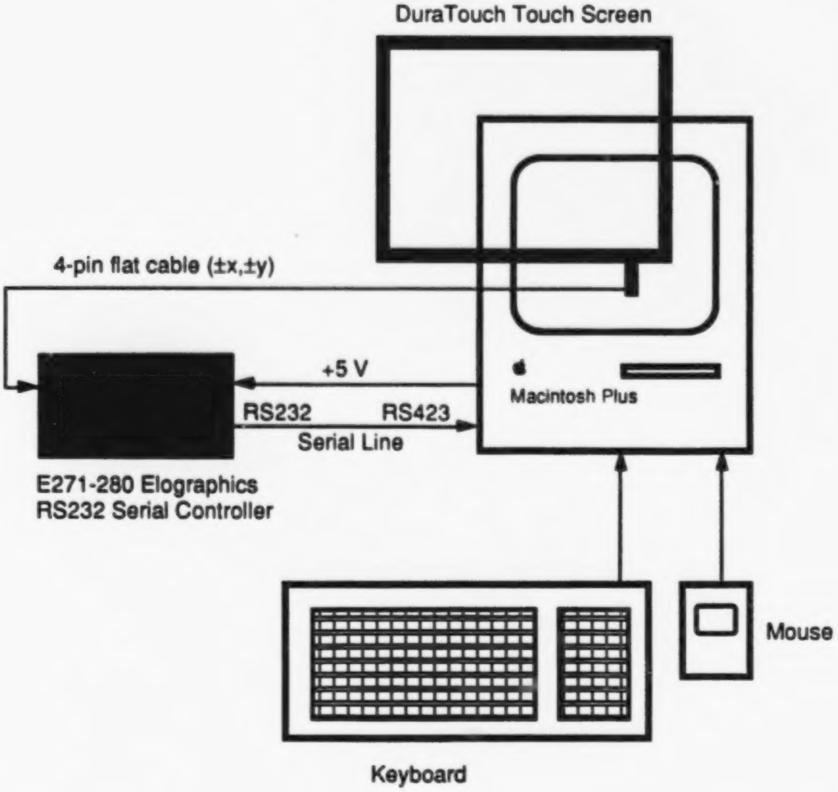
InitSer uses the Macintosh RAM serial driver to initialize the serial modem port for 9600 baud, no parity and 7 data bit communication with the touch screen. It is used at the beginning of any program which uses the touch screen.

CalibrateTS establishes the mapping of touch screen coordinates to screen coordinates by asking the user to press the corners of the active window. From the received coordinates, horizontal and vertical scaling factors are determined. Note that the active window may be any size from full screen to only a small portion of the screen.

CheckSerPort, *FlushSerBuf* and *GetTouch* are used to maintain the serial port input buffer. *CheckSerPort* checks for the presence of data in the serial port input buffer; *FlushSerBuf* clears the buffer; and *GetTouch* returns the oldest data in the buffer.

The approximate cost of the Macintosh Touch Screen project is $500. The majority of the budget was spent on the Elographics DuraTouch touch screen. Software tools were already available from Fircrest for the software development portion of this project.

Macintosh Plus Touch Screen
General Configuration



"Remote Controller for Traffic Lights" An Aid in Educating the Mentally or Physically Disabled in Pedestrian Safety

Designers: George Lippincott and Woobin Lee

Disabled Coordinator: Dr. John Eiler of Fircrest School

Faculty Supervisor: Dr. Yongmin Kim

Department of Electrical Engineering
University of Washington
Seattle, WA 98195

INTRODUCTION

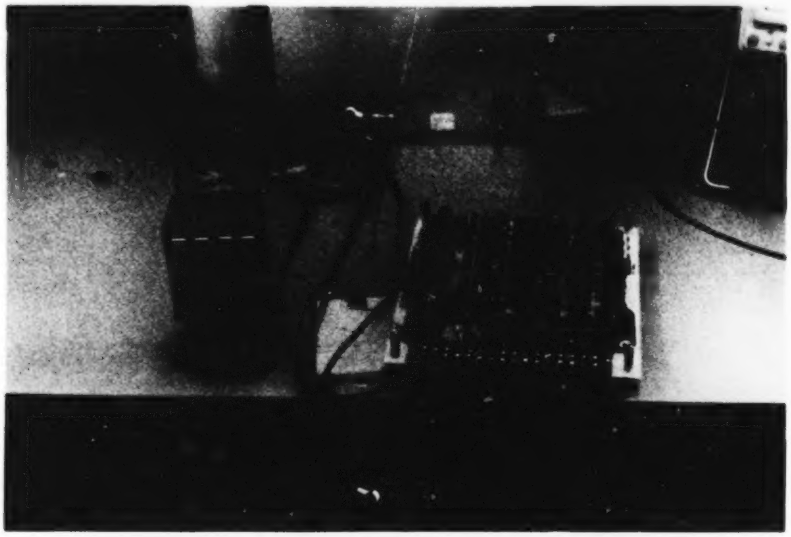
Fircrest School has obtained donations of several traffic signal lights for potential application in teaching basic community survival skills to developmentally disabled students, within the safety of the campus. While staff are available to mount this equipment, a control device is necessary to enable the instructors to unobtrusively operate the signals in training situations.

The Traffic Light Controller, which consists of a hand-held transmitter and a receiver capable of controlling the lights for a single intersection, incorporates four pushbuttons and three toggle switches on the transmitter. Using the pushbuttons, the instructors can decide if they want the lights to be controlled automatically or if they would like to control the lights themselves. A dial on the transmitter allows the instructor to control the speed at which the lights automatically change. The toggle switches allow for manual control of the traffic lights by the instructor.

SUMMARY OF IMPACT

Fircrest School is home to about 500 mentally or physically handicapped people. Although most are permanent residents, some will leave the school to live on their own or in halfway houses. Fircrest has acquired two sets of traffic lights and walk signals for use in teaching clients how to obey traffic lights and to safely cross intersections. In order to teach pedestrian safety effectively, instructors must be able to simulate a normal intersection at many different locations on their campus since it will be important for the clients to become responsive to the traffic signals in a variety of surroundings and situations.

For the handicapped individual to be able to live independently, either on their own or in a halfway house, basic survival skills for the city, such as pedestrian education and safety, need to be mastered. The Remote Controller for Traffic Lights should be very helpful in training these handicapped individuals to cross the street in a safe and familiar environment.



The remote controller consists of two units: a hand-held transmitter and a receiver. The transmitter includes a dial to control the cycle rate of the traffic signals under automated control, toggles to vary the operation under automated control, and four pushbuttons to override automated control and allow manual operation of the traffic lights.

RF communication between the transmitter and receiver was built around the RF circuitry of an electric toy car. The RF carrier signal is pulsed using a form of PCM: a long pulse represents a '1' and a short pulse a '0'.

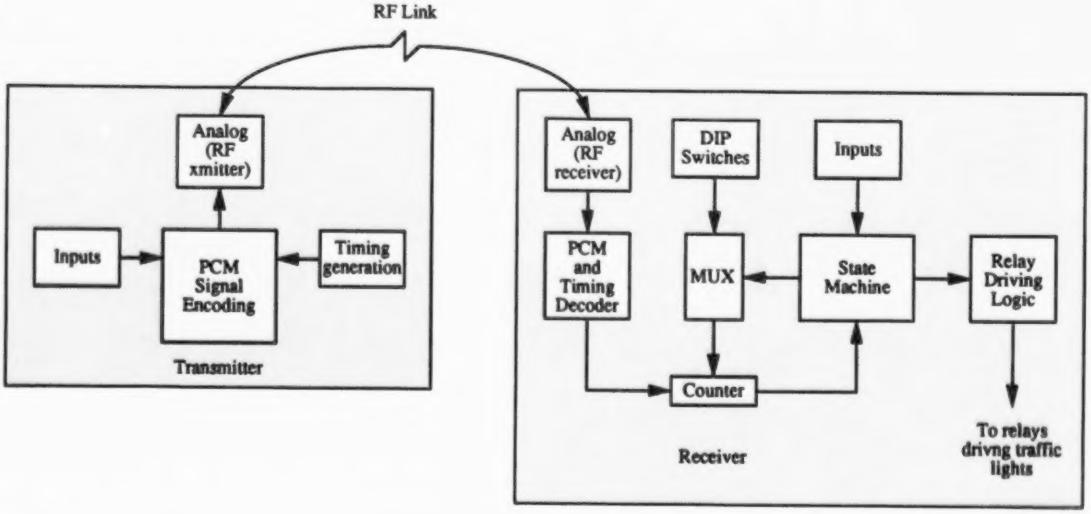
The receiver unit contains the state machine which controls the traffic lights. It consists of an analog portion which receives and translates the transmitted RF signal, a 10 state finite state machine and a power output section which drives relays to the traffic lights.

Clocking of the state machine is under the control of the hand-held transmitter. The transmitter periodically sends out small data packets indicating the current state of the input switches. 2 bits are for the pushbutton status, 3 bits are for the status of the toggle switches, a single bit for timing (or system clock) and a single parity bit.

Every 16th transmission triggers a one-shot. While the one-shot is active, transmission of the timing bit is blocked. The pulse width of the one shot is controlled by a potentiometer which can be adjusted via the dial on the transmitter. This arrangement allows the clocking to be varied in increments of 1/16 of the maximum transmission rate (currently 8 Hz). Slower rate can be obtained by using the 'Next State' toggle on the transmitter.

The states of the finite state machine (FSM) on the receiver unit have a one-to-one correspondence to the pattern of ON and OFF traffic lights. Each state is decoded and drives the traffic light relays. The TTL signals are used to drive NPN transistors whose collector currents in turn activate the relays.

The approximate cost of the project is $350.


RF Link
Analog (RF xmitter)
Inputs
PCM Signal Encoding
Timing generation
Transmitter
Analog (RF receiver)
DIP Switches
Inputs
PCM and Timing Decoder
MUX
State Machine
Relay Driving Logic
Counter
To relays drivng traffic lights
Receiver

"Portable Data Collector Unit"
A Data Collector for Use in Behavioral Treatment Programs

Designers: David McKinstry and Donald Lee Pierce

Disabled Coordinator: Dr. John Eiler of Fircrest School

Supervising Professor: Dr. Yongmin Kim

Department of Electrical Engineering
University of Washington
Seattle, WA 98195

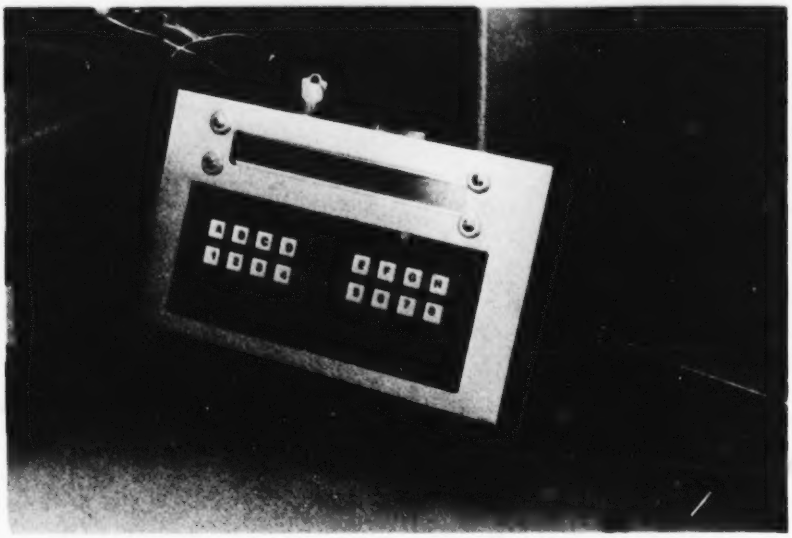
INTRODUCTION

The Portable Data Collector Unit (PDCU) is designed to track and record adaptive and maladaptive behaviors, as well as behavioral reinforcements, of mentally and physically disabled individuals in a treatment program. This data is currently being collected at Fircrest School in Seattle, using Videx optical bar code scanners. These readers are very attractive because of their small size, their ability to run all day on batteries without a recharge, and their ease of operation. Data is downloaded through a Macintosh modem port when the scanner is placed into its recharger.

The Portable Data Collector Unit replaces the optical scanners with a simple keypad and display system, and is an improvement over the present system. A menu-driven display which prompts for and only permits entry of data in the correct sequence reduces errors and the need for data editing. Data transfers to and from the data collector take place over a serial link to either a Macintosh or IBM-compatible personal computer.

SUMMARY OF IMPACT

Fircrest School is a residential treatment facility in Seattle for the developmentally disabled. Many of its residents have treatment programs which require that a staff member constantly monitor and reinforce their behavior. In order for behavioral training programs to be effective, adaptive and maladaptive behaviors and any reinforcements that are given must be accurately tracked and recorded by the staff. Accurate collection of this data using the Portable Data Collector can then permit psychologists to refine and optimize the treatment program for these handicapped individuals.



The PDCU is housed in a 10" x 5" x 2" metal enclosure. Mounted on the top surface is a 40 x 2 character Sharp LCD display. Below the LCD are two 3 x 4 membrane keypads placed side-by-side. On one end of the box are a locking keyswitch to turn the PDCU on and off and a DB-25 connector for RS-232 communication.

The 40 x 2 character display is divided into an array of 8 x 2 display fields. The top two rows of the keypads have a one-to-one correspondence with these display fields, resulting in a large matrix of 16 programmable "soft-keys". Two of the remaining 8 keys in the bottom row are used as ENTER and CLEAR keys. The rest are available for future expansion.

The PDCU is controlled by an Intel 8031 microcontroller. 8 Kbytes of program memory is provided by a 27C64 EPROM; 32 Kbytes of data storage is provided by a 62256 static RAM. The LCD display and the two keypads are interfaced to the 8031 via its I/O ports. RS-232 downloading capability is provided through the built-in serial communications port of the 8031. The serial port's TTL levels are shifted to RS-232 levels by a +5V Maxim MAX232 transceiver (which eliminates the need for the bipolar power supply used by most RS-232 transceivers).

The keypads are read by using a row scan technique. Each row is strobed in turn by a low pulse. When a key is pressed, the low pulse is transferred to a column which is detected by the microcontroller. The row and column pair uniquely identifies each key.

The 8031's internal timer is used to implement an interrupt driven clock to track the time of day for the system. The remaining interrupt is used for the RS-232 serial communication.

The software implements a hierarchical menu system. At the highest level, client names are displayed. If the corresponding soft-key is pressed, then a list of behaviors is presented that may be recorded for that patient. At the end, the information is redisplayed for verification by the clinician. By forcing the user to use this prompted input format, data entry errors are minimized over the current bar code system.

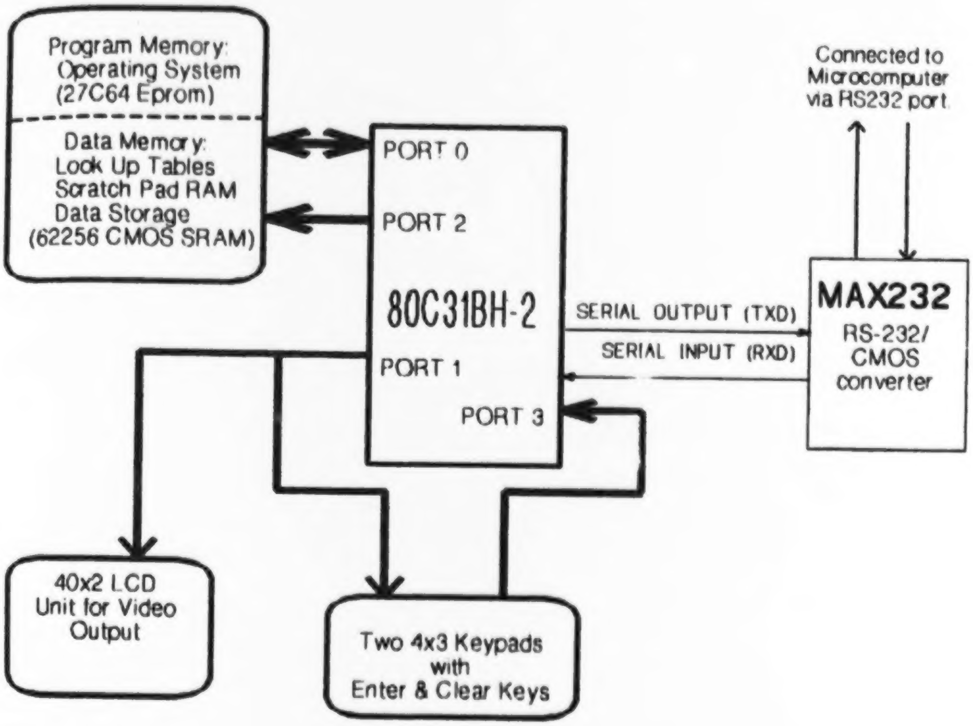
The approximate cost of this project is $275.

Portable Data Collection Device

Block diagram for proposed EE478 project

Lee Pierce and Dave McKinstry

02/24/88


Program Memory: Operating System (27C64 Eprom)
Data Memory: Look Up Tables Scratch Pad RAM Data Storage (62256 CMOS SRAM)
PORT 0
PORT 2
80C31BH-2
PORT 1
PORT 3
SERIAL OUTPUT (TXD)
SERIAL INPUT (RXD)
Connected to Microcomputer via RS232 port
MAX232
RS-232/ CMOS converter
40x2 LCD Unit for Video Output
Two 4x3 Keypads with Enter & Clear Keys

"Safety Sensor System"
An Electronic Bed Safety Device for the Physically and Mentally Disabled

Designers: B. Kongsang, S. Chen, and R. Farahi

Disabled Coordinator: Dr. John Eiler of Fircrest School

Supervising Professor: Dr. Yongmin Kim

Department of Electrical Engineering
University of Washington
Seattle, WA 98195

INTRODUCTION

The Safety Sensor System is designed to detect the activity of a mentally or physically disabled client while that individual is confined to bed, and set an alarm to help prevent the client from falling out of bed. In order to predict whether the client is going to leave the bed, there must be some way to detect the client's position on the bed. The Safety Sensor System measures the weight under each bed leg and calculates the center of gravity of the client on the bed. By knowing the location of the center of gravity, the location of the client on the bed can be determined. The static analysis for determining the center of gravity is straightforward and requires knowing the weight on only three of the bed legs. An alarm activates when the center of gravity comes "too close" to one of the edges of the bed. A safety region will be specified by the user of the system, who normally is a supervisor, nurse, or other staff.

The Safety Sensor System is physically attached to the bed, and it is small and portable for easy installation. In order to ensure patient safety, the Safety Sensor System is enclosed in a small box which protects the clients from accessing any of the electrical components and wires. A key switch is used to ensure the system's functionality. Only staff who have keys to the key switch can reset the system. Otherwise, the system will be in the surveillance modes all the time. This prevents the system from being unintentionally stopped by the clients.

SUMMARY OF IMPACT

Fircrest School in Seattle is a residential facility for the developmentally disabled. Several Fircrest School students with severe mental disabilities require restraining devices while sleeping. If these students leave their bed unassisted, they could injure themselves. Currently, soft waist restraints have been utilized at Fircrest School, but the use of less restrictive electronic sensor systems may enhance the independence and quality of life for these disabled persons, while adequately guarding their safety. The Safety Sensor System could be used in other settings, such as nursing homes and hospitals where patients need close monitoring, especially during reduced staffing periods at night.

The Safety Sensor System consists of a main controller unit and four strain gauge units. Each of the strain gauge units is mounted underneath one of the legs of a bed. Signals from the strain gauge units are transmitted to the controller as current loops over twisted pair wire.

The controller unit is designed around the Motorola 68705U3 microcontroller. Devices interfaced to the microcontroller include a 16 by 2 LCD display, a 12-bit CMOS A/D converter, a key switch and BCD dial switches.

The LCD display provides feedback to the staff while configuring the system. The user is prompted step-by-step to enter the safety boundaries and when to place the client in the bed. The BCD dial switches are used to input the safety region dimensions.

Each of the strain gauge units uses two 120 ohm resistive strain gauges. Each gauge is bonded above and below a cantilevered beam upon which the bed leg rests. As the beam bends under the weight of the bed, the gauges on top and bottom undergo tensile and compressive stresses, respectively, which produces resistive changes. The gauges are used in a Wheatstone bridge configuration with two other precision 120 ohm resistors so that the changes in resistance can be detected as a voltage signal.

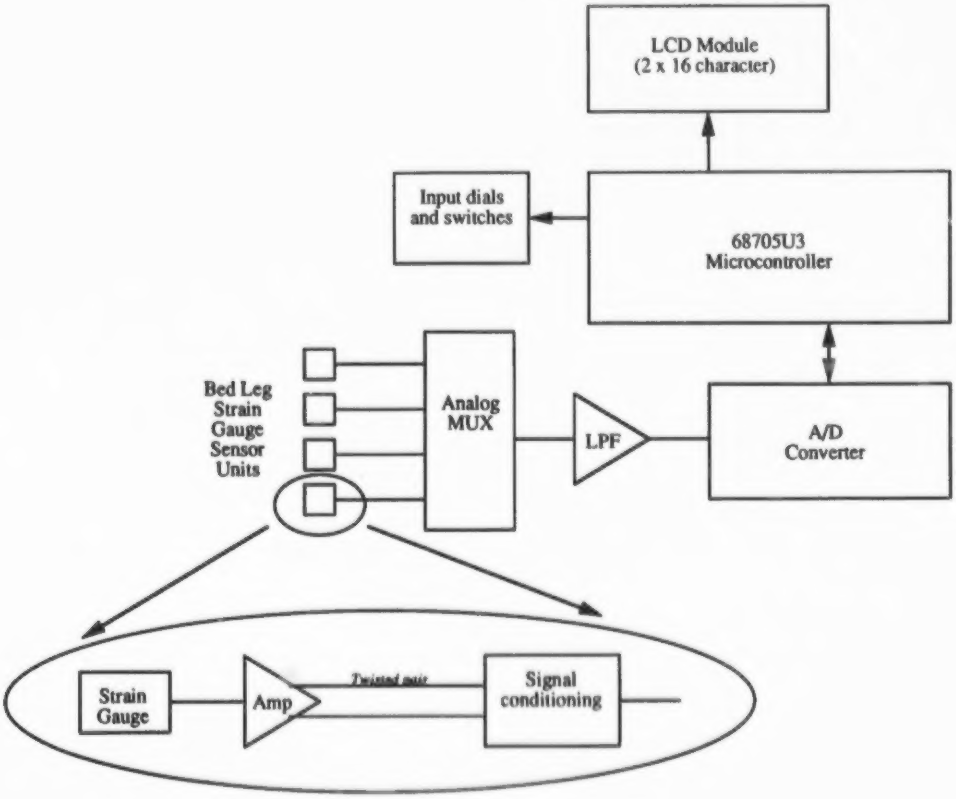
Low-level voltage from the strain gauges is amplified and converted to a current for transmission as a variable current loop by an Analog Devices AD693AD sensor transmitter.

On the controller unit, the current loop signal is transformed back into a voltage signal by a load resistor and further amplified and lowpass filtered. The final signal output of 0 to 4 volts corresponds to a weight range of 50 to 350 pounds. The four resultant signals, one from each strain gauge unit, is directed to the A/D converter by a four input analog multiplexer.

The center of gravity of the client is calculated by the microcontroller using the weight sensed at three of the legs (the fourth is needed to calculate the total weight of the client). If the center of gravity leaves the defined "safety zone," then an alarm signal is activated. The alarm signal is armed or disarmed by the keyswitch position.

Note that all calculations are done with integer arithmetic.

The approximate cost of the Safety Sensor System is $550.



"Electromyographic (EMG) Switch"
A Biofeedback Device to Measure Muscle Potential

Designers: Gary Cheung and Rondy Ng

Disabled Coordinator: Dr. John Eiler of Fircrest School

Supervising Professor: Dr. Yongmin Kim

Department of Electrical Engineering
University of Washington
Seattle, WA 98195

INTRODUCTION

The Electromyographic (EMG) Switch is specially designed to measure muscle potential during contraction and relaxation. This device is microcontroller based and has options normally not available in some of the commercial ones. It will provide precise artifact-free feedback in virtually any environment. The device may be used with surface electrodes on any part of the body. This device is designed to provide biofeedback for a wide range of portable EMG applications. To help stimulate learning of biofeedback techniques, two jacks are provided to allow control of reinforcers in response to muscle tension.

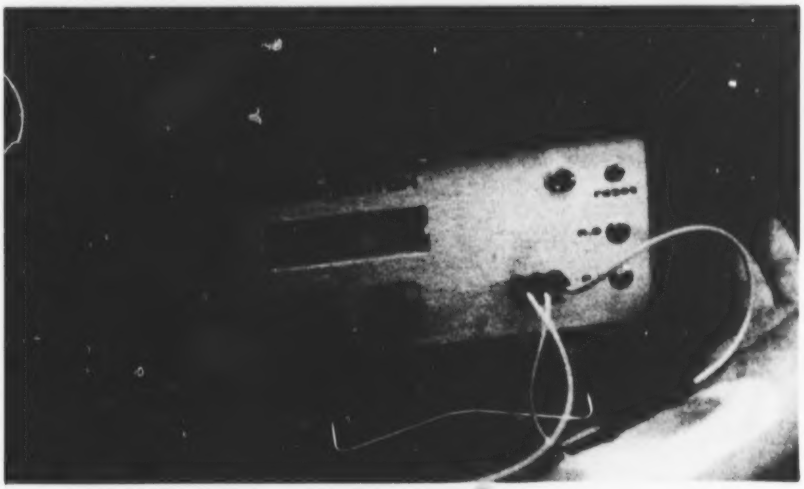
The EMG biofeedback electrode-assembly consists of two active and one inactive electrodes. The active electrodes are placed in a bipolar configuration on the skin along the long axis of the muscle. The amount of EMG recorded is the algebraic sum of all action potentials of the contracting muscle fibers between the electrodes. Since this device is designed to be used by people with no prior experience with EMG, only two buttons are used to implement all of the functions.

SUMMARY OF IMPACT

Fircrest School in Seattle is a residential facility for the developmentally disabled. The EMG switch was designed for the clients at the Fircrest School, who have mental and/or physical handicaps. Some of these handicaps involve abnormal muscle contraction and relaxation that are easily triggered by external events such as hand clapping.

Electromyography (EMG) is a technique used in diagnostic neurology for the investigation of patients presenting neuromuscular disorders. The investigation is performed on the neuromuscular apparatus and essentially consists of recording the action potentials generated by muscles and nerves. That muscular contraction produces electrical activity which is connected with discharges generated in the muscle fibers and that most of these discharges have been induced by impulses coming from the nervous system.

EMG has been used in clinical settings to correlate with states of tension or stress. Recordings are taken to reflect the level of muscular tone which in turn reflects the mental and emotional level of the patient. The most promising research with EMG is in biofeedback research in which patient is given the EMG records and learns to gain control of specific areas of his skeletal musculature - relaxing or contracting them at will. Usually, the patient is given auditory and/or visual displays of his individual myoelectric potentials recorded by means of electrodes. The cues provide the patient with an awareness of the twitching of individual muscle units. He may learn in a few minutes to control this activity and can give many responses with only the feedback cues as a guide. The aim of the EMG Switch is to teach the patient to gain control of his muscles and learn to correct such abnormal muscle behavior through biofeedback.



The EMG Switch (EMGS) is packaged in a 6" x 6" x 2-1/2" metal enclosure. On the front panel are an LCD display, two buttons, an LED power light, a reset button, two phone jacks for external devices and three jacks for the surface electrodes.

The EMGS is designed around the Motorola MC68705U3 EPROM microcontroller. It includes 3.8 Kbytes of ERPOM, 128 bytes RAM, an internal timer and 4 8-bit I/O ports.

The electrode signals are fed directly into a differential instrument amplifier. Two electrodes serve as the amplifier's inputs and the third serves as an analog ground. The amplified signal is then conditioned by passing through three filters: a 2nd-order Butterworth LPF, a 2nd-order Butterworth HPF and a biquad elliptical notch filter.

The LPF and HPF together form a bandpass filter to band limit the signal before digitization. The notch filter is tuned to reject 60 Hz power line interference.

The filtered signal is amplified and rectified prior to digitization byt the 12-bit A/D converter (Teledyne TSC8705).

The internal timer of the microcontroller is used to measure the "tensed" and "relaxed" EMG signal duration times of the test subject.

The I/O ports of the microcontroller are used to interface to the LCD display, the A/D converter, the input buttons and the output relays.

The user interface consists of a 16 character by 2 line LCD display and two push buttons. The top line of the display is used to relay status information. The bottom line of the display is used to label the current function of the buttons mounted just below the display (i.e., soft switches).

The software supports continuous monitoring of the EMG signal value, calibration of tense and relaxed EMG levels, calculation of an activation threshold level (for biofeedback) and control of external electrical devices (via the output relay) through EMG biofeedback techniques. The system was sucessfully integrated and demonstrated. It is being used by the Fircrest School.

The approximate cost of the EMG Switch is $300 (not including the non-reusable electrodes).

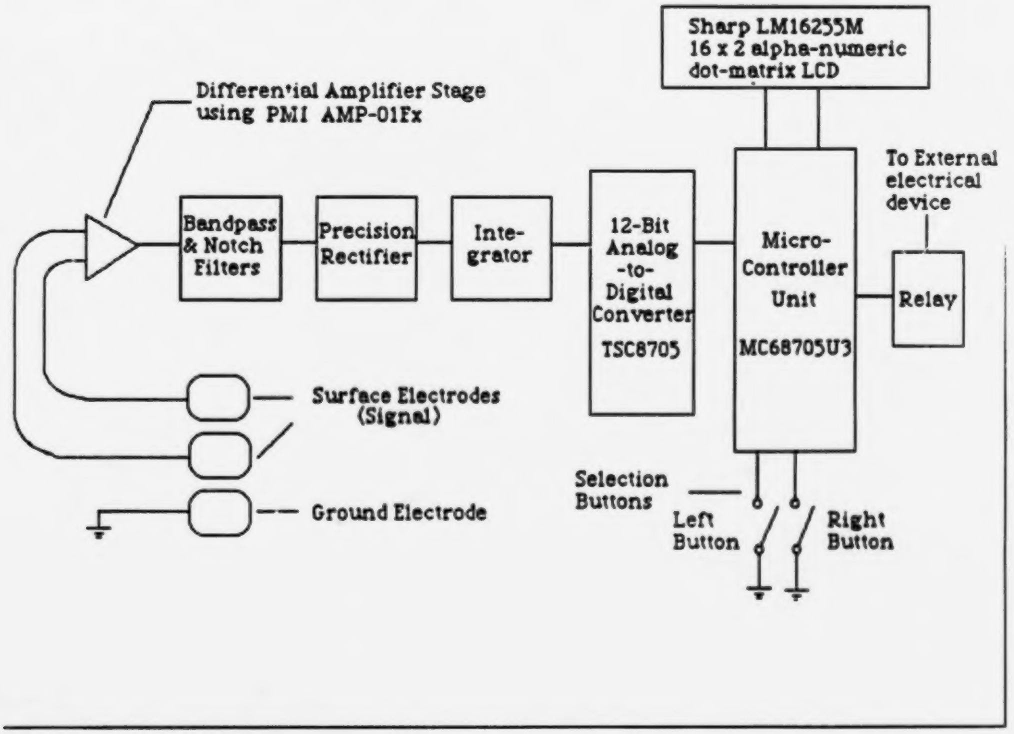

Sharp LM16255M
16 x 2 alpha-numeric
dot-matrix LCD
Differential Amplifier Stage
using PMI AMP-01Fx
Bandpass
& Notch
Filters
Precision
Rectifier
Inte-
grator
12-Bit
Analog
-to-
Digital
Converter
TSC8705
Micro-
Controller
Unit
MC68705U3
To External
electrical
device
Relay
Surface Electrodes
(Signal)
Ground Electrode
Selection
Buttons
Left
Button
Right
Button

Fig. 1. Block Diagram of the EMG Switch

"Telephone Training Set"
A Teaching Aid for the Physically and Mentally Disabled

Designers: David T. Kirkland II and Hsien Li Young

Disabled Coordinator: Dr. John Eiler of Fircrest School

Supervising Professor: Yongmin Kim, Ph.D.

Department of Electrical Engineering
University of Washington
Seattle, WA 98185

INTRODUCTION

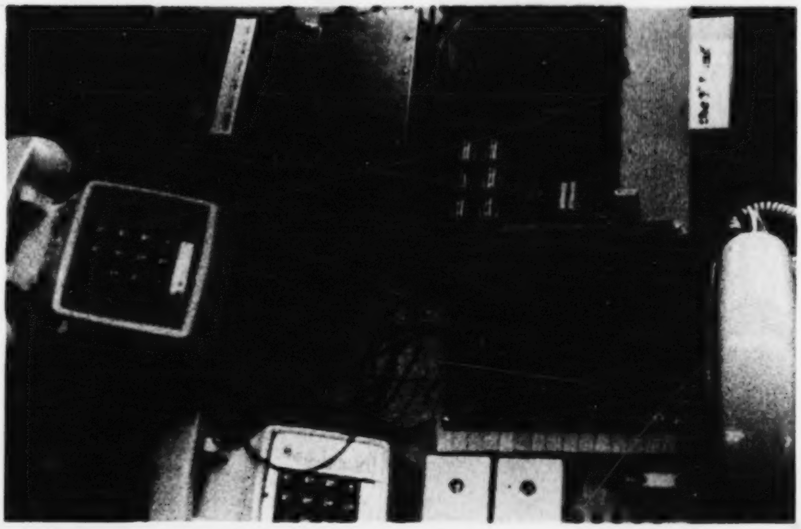
The Telephone Training Set is a training device for the physically and mentally disabled. The system includes a teacher console, teacher headset, student phone, third-party phone, and recording capability. A jack is provided so that the output of a tape recorder can be directly coupled to the phone line through a transformer. The phone set will facilitate training in the functions of telephone usage, utilizing ring and tone generation, handling recorded messages, and dialing capabilities. The dialing at the student station, as well as an on-hook or off-hook indicator for the student phone are displayed at the teacher station.

The basic requirement for the telephone training set is to allow a teacher to have complete monitoring and controlling capabilities of a remote student telephone station, with the option that a third-party could participate at a different station. The teacher is able to control the tones that would normally be generated by the telephone company, such as dial and busy tones, and is able to control the ringing of the student phone. The set also has the facility to play recorded messages, such as those encountered when an invalid number is dialed.

SUMMARY OF IMPACT

The Telephone Training Set was developed as a training device for the physically and mentally disabled. It was developed to a set of requirements derived by the faculty at the Fircrest School of Seattle, and built for use by this school, which is a residential treatment facility for approximately 500 developmentally disabled individuals.

When successfully trained using this telephone set, the handicapped individual can gain greater independence in one important area of daily living, placing and receiving phone calls. This capability can be of vital importance especially to those individuals who will eventually leave the facility to live independently or in a halfway house.



The Telephone Training Unit (TTU) was designed as a realistic teaching tool to familiarize disabled students with the operation of standard telephone equipment. One of the chief design criteria was that the system must maintain a high degree of realism. To that end the TTU incorporates real phones in a simple telephone loop. In addition, a monitoring and control station is coupled into the loop to allow the teacher to maintain the behavior of the setup.

The system is organized as a basic telephone loop; devices are inductively coupled into the loop with transformers. Two telephones are connected into the system loop for the students to use. An additional phone is provided for the teacher to monitor "calls".

At the teachers station, there is a display that indicates the off-hook condition of the telephones as well as displaying the number that has been dialed on the telephones.

The off-hook condition of a telephone is detected with the aid of a current sense resistor. When a telephone handset is picked up, a switch is closed which causes DC current to flow in the loop. The voltage developed across the sense resistor is amplified and filtered by an active filter to produce the off-hook signal. This signal activates the LED indicator at the teacher's console.

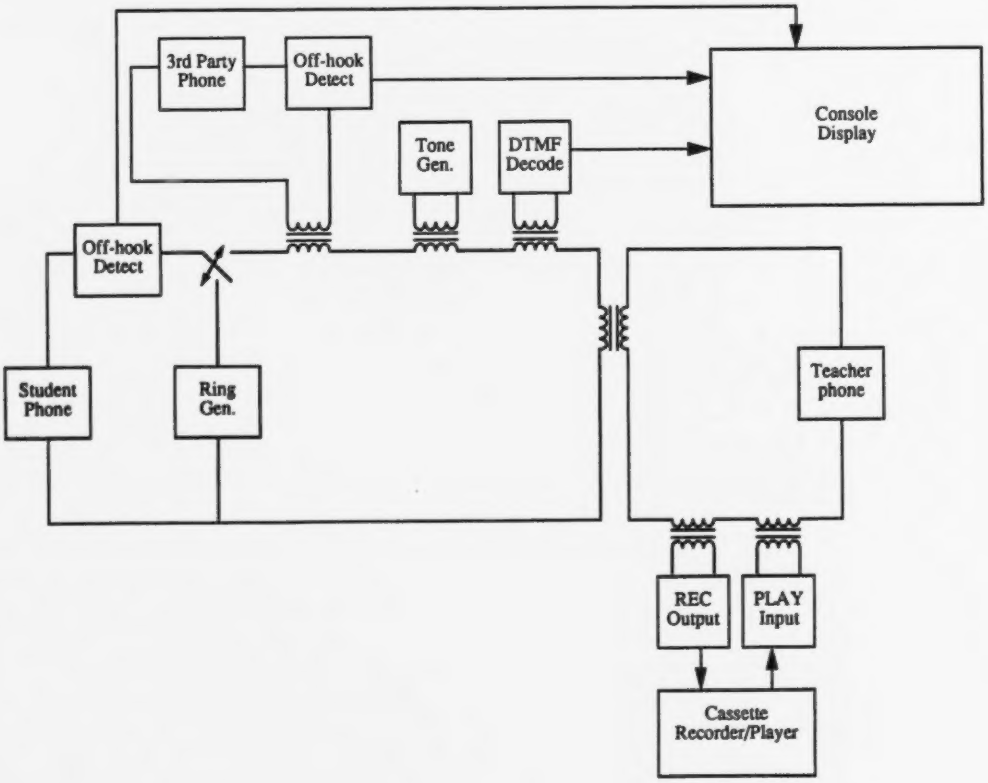
The number dialed by a student is displayed at the teacher's console on a multiplexed LED display. Each digit is detected and decoded using a DTMF decoder chip which translates the touch tone signal into a BCD digit. As each digit is received, it is loaded into the LED display. The display can accommodate up to 15 digits.

Generation of the busy, dial, ring-back and off-hook tones are created by summing together sinusoidal signals. The different frequencies (eight total) are generated using function generator chips. The appropriate frequencies are added together using op-amp summing circuits for each of the tones. The appropriate tone is selected by using an analog multiplexer. The chosen tone signal is coupled into the telephone loop by a transformer.

A ringing telephone requires a 120V, 30 Hz signal. This is produced by a special purpose ring generator chip. It is switched into the circuit by a relay switch.

The TTU has record and play jacks for connection of tape recorders so that prerecorded messages (i.e., "Please dial again...", "That number is no longer in service...", etc.) can be used to respond to student inputs. This also makes it possible to record student interaction with the TTU setup.

The approximate cost of this project is $750.



"Intelligent Wheelchair Controller"
A Safety Device for the Physically and Mentally Disabled

Designers: Richard Burton and Randy Stamper

Disabled Coordinator: Dr. John Eiler of Fircrest School

Supervising Professor: Dr. Yongmin Kim

Department of Electrical Engineering
University of Washington
Seattle, WA 98195

INTRODUCTION

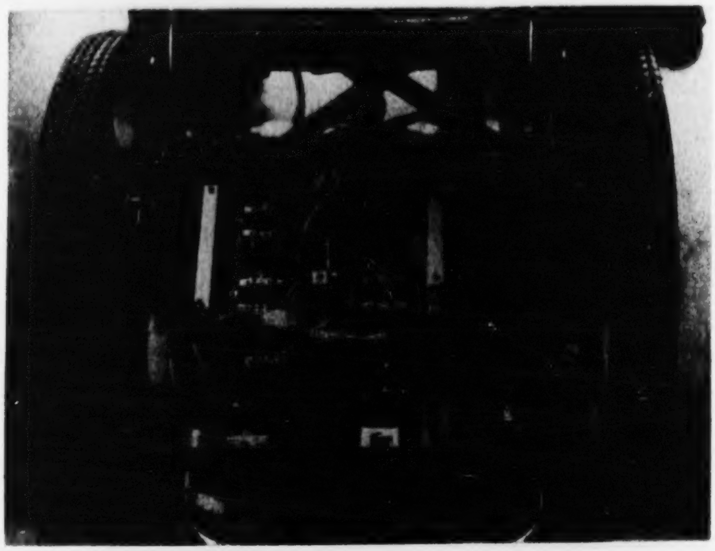
The Intelligent Wheelchair Controller is an electric wheelchair controller that incorporates a number of safety features to effectively reduce the risks of injury to the physically or mentally disabled individual who relies on an electric wheelchair for mobility. The controller puts constraints on such parameters as speed, acceleration, and maneuverability, as well as incorporating an ultrasonic sensor system to detect oncoming obstacles.

A late addition to the project was an infrared tape tracking system whereby the wheelchair would follow prelaid tracks of non-reflective tape. The operator applies pressure on the joystick and wheelchair will do the rest. The system should be able to follow a straight line or turn a 90 degree corner.

SUMMARY OF IMPACT

Mobility is a key problem among many disabled people. The electric wheelchair was designed to be an effective solution to this problem, although it has some drawbacks. A major drawback is that there are handicapped individuals who cannot control their physical actions to any reliable degree, and therefore run into potentially dangerous situations when operating an electric wheelchair.

Since the handicapped individuals using electric wheelchairs can vary so much in their level of disability, the Intelligent Wheelchair Controller is a useful tool in preventing accidents. For instance, without the controller, the individual can sometimes jam the joystick forward full throttle, unable to control the speed of the wheelchair. If this were allowed to happen, they will eventually ram into something or someone inadvertently, thus subjecting themselves and others to the possibility of serious injury. The ultrasonic sensor system to detect oncoming obstacles will also be of great help in preventing collisions. The ultimate goal of the Intelligent Wheelchair Controller is to enable the handicapped individual to function as independently as possible with minimal supervision.



The Intelligent Wheelchair Controller (IWC) setup includes a processor board enclosed in a large 1 foot by 1 foot by 5 inch box plus a potentiometer-type joystick, sonar sensor and infrared emitter/detectors.

The joystick allows the user to provides direction and speed control inputs to the processor board.

The sonar sensor is used to provide of the most important saftety features of the IWC. It detects objects in front of the wheelchair to prevent collisions.

The IR emitter detector pairs are mounted on each wheel with slotted disks interposed between the emitter and detector. As the wheels (and the disks) spin, the slots cause the detectors to see a train of pulses which translates into wheel speed.

Finally, another set of IR emitter/detector pairs is used to provide the wheelchair with a reflective tape tracking mechanism.

The IWC was designed around an Intel 80186. The 80186 was chosen because many of the peripheral functions normally provided by external chips (i.e., memory decode, interrupt control, timers, etc.) are already integrated into the device.

A total of 80Kbytes of memory is interfaced to the 80186--64Kbytes of EPROM and 16Kbytes of SRAM. The EPROM contains the startup and IWC code while the SRAM stores the interrupt vectors and program data.

Four 8-bit input and four 8-bit output ports are provided to interface with external devices such as the joystick and IR emitter/detector pairs. Since the digital input devices are mounted up to a meter (1 m) away, all the digital inputs are feed through Schmitt triggers to help reject noises and glitches caused by reflection problems.

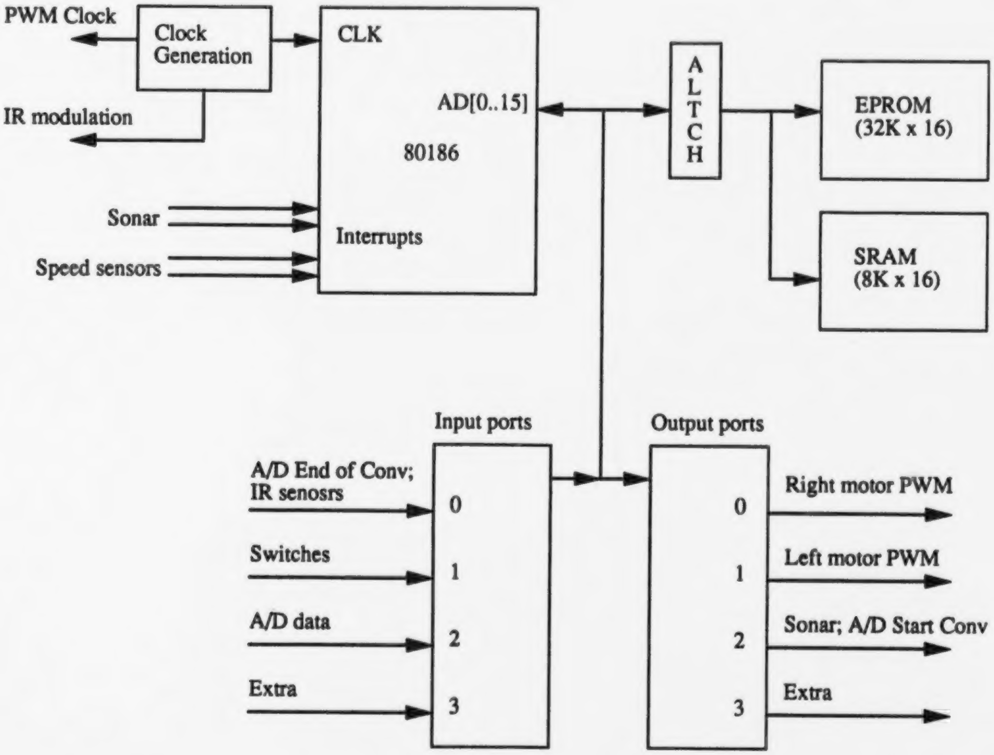
In order to process the joystick input, the joystick potentiometers are connected to an A/D converter which digitizes the joystick's X and Y positions. The potentiometer outputs are filtered with 1 uF capacitors to remove any glitches that might occur.

Continuous speed control of the motors is provided by using pulse width modulation (PWM). As a safety precaution, a 100ms one-shot is provided so that if the motors are driven continuously for more than this time (due to a hardware or software failure), then the motors will be cut off. Motor direction is controlled by relays which can reverse the current flow through the motors.

The built-in timers of the 80186 are used to provide real time and as a range finder for the sonar signal.

Power is provided by two 12 volt automobile batteries connected in series to provide +12 and +24 volt outputs.

The approximate cost of the IWC is $500 - 600.



"Everest and Jennings Infrared Mobility System (JIM)"
A Motorized Wheelchair for the Disabled

Designers: Warren Edwards and Cam Ritchie

Disabled Coordinator: Dr. John Eiler of Fircrest School

Supervising Professor: Dr. Yongmin Kim

Department of Electrical Engineering
University of Washington
Seattle, WA 98195

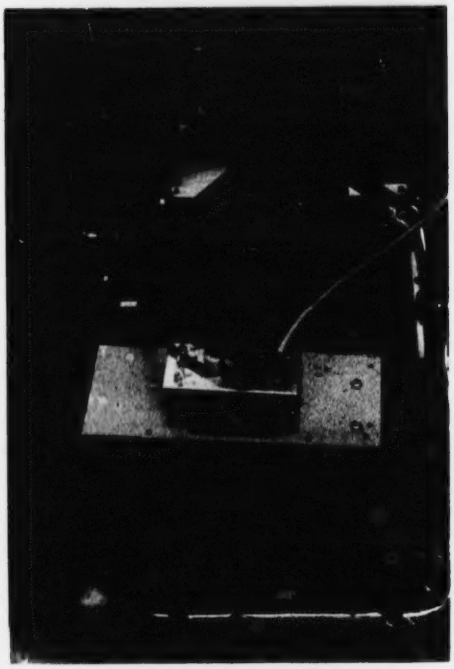
INTRODUCTION

The Everest and Jennings Infrared Mobility System (JIM) is a versatile motorized wheelchair. JIM can be used for training purposes as well as for everyday personal transportation. JIM's features include five speed settings and is equipped with a sonar collision detection system that will stop the wheelchair whenever it comes within six feet of an object directly in front of it. JIM also features an infrared tape tracking system that will allow those clients being trained on motorized wheelchair control to do so safely. For those clients who are unable to use the attached joystick control, JIM is flexible enough to allow the attachment of alternate control methods such as lighted microswitch panels. JIM's control functions are centralized in two positions on the chair. Input from the user is accepted at the joystick interface on the right arm rest of the chair's seat. The instructor controls are centralized behind the seat and allow the instructor to configure the chair for each client.

JIM incorporates a number of safety features. Its maximum speed is slow enough that it is not a hazard and the user is protected from collisions by the sonar. JIM's joystick is also equipped with a time-out feature that automatically turns the wheelchair off if there has been no change in the joystick position for six seconds. This feature prevents any client from moving in an uncontrolled fashion due to a seizure or muscle spasms.

SUMMARY OF IMPACT

Training mentally and physically disabled clients to use their motorized wheelchairs involves a step by step process to teach independence and safety. This training process is currently being developed at Fircrest School in Seattle, a residential treatment facility for developmentally disabled clients. The first step in the training process is to familiarize the client with the motorized wheelchair, with subsequent stages of the training procedure giving the client higher levels of independence. The ultimate goal of JIM is to enable the handicapped individual to function as independently as possible with minimal supervision.



The Everest and Jennings Infrared Mobility System (JIM) is an upgrade of the Intelligent Wheelchair Controller (IWC). The power consumption characteristics are improved and the tape tracking mechanism expanded and made more reliable.

One of the problems with the power distribution of the IWC was that it causes more power to be drawn from one of the two batteries than the other. Furthermore, the voltage regulators are inefficient when converting the available +12 volts to a relatively low +5 volts. In JIM, a more efficient switching power supply was substituted for the 5 volt regulators. Also, all the TTL parts were replaced with equivalent 74HC-series CMOS parts and the 80186 CPU was replaced with the CMOS version.

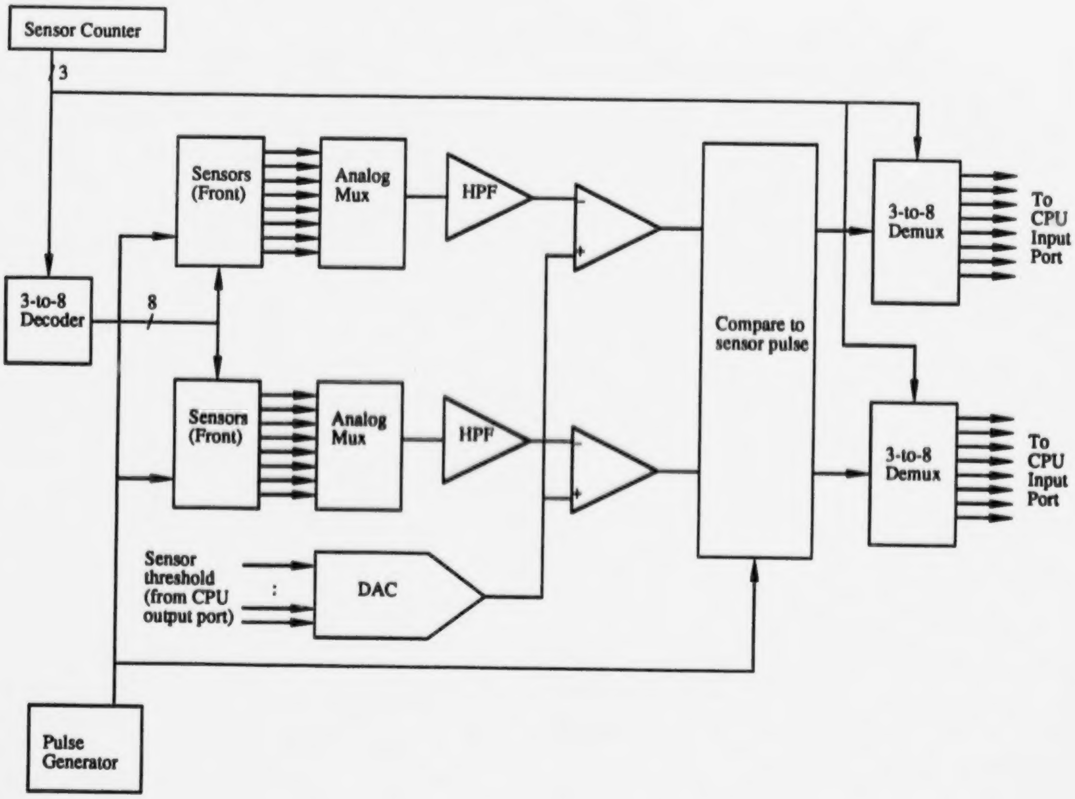
The infrared sensor array for the tape tracking mechanism is organized as two banks of eight emitter/detectors sensors. One bank is located behind the front wheels of the wheelchair and the other is located behind the battery compartment at the rear. Each sensor is mounted on a small 1-1/2" x 1" printed circuit board (PCB). They are connected to the 15" wide mounting rail by DB-9 connectors at 1-7/8" intervals. This arrangement allows damaged sensors to be removed for repair or replacement.

The sensors are strobed in sequence by the output of a 3-to-8 decoder (front and back simultaneously). The decoder is contolled by a 3 bit Sensor Counter. This arrangement prevents the IR from neighboring sensors from contaminating the amount of detected light. The sensor outputs are sequentially read back by 8-to-1 analog multiplexers. The multiplexer output is filtered by a 3 pole highpass Butterworth filter to remove interference from the ambient room light. This filtered signal is fed into an analog comparator and compared with the calibrated threshold level.

Each sensor is pulsed four times. If four pulses are detected, then the sensor is regarded as being above the reflective tape. This, coupled with the sensor number in the Sensor Counter, is used to produce the sensor signls to the spare IWC 80186 input ports (via 3-to-8 demultiplexers).

The IR sensor system is interfaced to the original IWC box by a DB-25 connector. It uses the extra 8-bit input port that was incorporated into the IWC for future expansion.

The approximate cost of this project is $300.



CHAPTER 18

WRIGHT STATE UNIVERSITY
COLLEGE OF ENGINEERING AND COMPUTER SCIENCE
DEPARTMENT OF BIOMEDICAL AND HUMAN FACTORS ENGINEERING
DAYTON, OHIO 45435

Principal Investigators:

Chandler A. Phillips (513) 873-3302

Blair A. Rowley (513) 873-3302

"Motorized Slant Board"

Designer: Carol Brunsman
Handicapped Coordinator: Peter Lanasa, Gorman Public School
Supervising Professor: Dr. Blair Rowley
Department of Biomedical and Human Factors Engineering
Wright State University
Dayton, OH 45435

INTRODUCTION

The motorized slant board is a tray that supports various keyboard and communication devices at many different angles. The angle of the board is controlled by a motor that is user-activated by a switch. In this way, the angle of the slant board can be adjusted so that the student can most easily see the monitor and keyboard without the need to change his position.

The device will be used by a student with athetoid cerebral palsy for keyboard activities.

SUMMARY OF IMPACT

A student who is affected by athetoid cerebral palsy has difficulty using a computer keyboard and other such devices due to a visual impairment that prevents him from accurately seeing narrowly defined areas on a flat surface. This inhibits his ability to press keys. Presently, he has to change positions to see the monitor, then the keyboard, and then to press the key. The student would be more efficient in keyboard activities and more academically productive if this problem was solved. The board was designed in close communication with the occupational therapist and teacher of the student, so that the board will best fit the needs of the student and school.

TECHNICAL DESCRIPTION

A slant board has been designed to stabilize a number of keyboard devices or books of many sizes. This slant board is adjustable to several angles by a motor controlled switch accessible to someone with a disability. The board also has a system to anchor it in one place on the workstation. The board is of suitable size to be used in various work places.

The design work and electrical assembly were done in the laboratory provided at Wright State University and at the home of the designer. The box and parts were fabricated and assembled by Tri-State Engineering in Cincinnati, Ohio. The criteria for an acceptable solution was a simple, inexpensive, easily implementable design that meets all specifications as developed by the teacher, occupational therapist and designer.

After the design specifications were developed and the state of the art was examined, the design work began. This design involves six basic systems, including: the box, a keyboard stabilization system, a system for stabilizing the box on a table, a tilt mechanism, a limit switching system, and the electrical system. The box size was determined by the places it would be used and the uses it would have. The keyboard is supported on the lid of the box in two ways. First, a fiddle is attached at the bottom of the lid. Then, Velcro strips will be placed on the surface of the lid. The keyboards and communication devices that will be used with this slant board will have Velcro attached to the bottom. This will prevent the student from accidentally knocking the keyboard off the slant board. The tilt mechanism uses an AC reversible motor to turn a screw. The next system to be examined is the limit switching. A switch bar on the end of the pillow block hits the oval plate of the switching mechanism which opens or closes a lever switch that determines the direction of the motor. The final system of the device is the electrical system. When the user closes his switch, the motor has power and turns in the direction specified by the switch. Two covers have been added to the inside of the box to cover the electrical equipment. This is to prevent someone from receiving a shock by accidentally touching some of the electrical parts.

The motorized slant board cost six hundred dollars ($600) to build. Since the device has an adapter to connect to any of various accessible switches at the Gorman School, it can be used by many students. We would like to thank the National Science Foundation for partially supporting this design project.

"Switch Controlled Page Turner"

Designer: Angela Obert
Handicapped Coordinator: Peter Lanasa, Gorman Public School
Supervising Professor: Dr. Blair Rowley
Department of Biomedical and Human Factors Engineering
Wright State University
Dayton, OH 45435

INTRODUCTION

The switch controlled page turner has the capability of turning the pages of a book one at a time in the forward direction. The student controls when the page is turned by closing a switch. The device stabilizes various sized books at several angles and also turns one page at a time. The angle can be manually adjusted by an attendant. Another way of changing the angle would be to have a motorized slant board that would be activated by the user closing a switch. This project was to make improvements on the page turner that was supplied by Gorman School.

SUMMARY OF IMPACT

This project was designed for individuals who have limited arm and hand control due to any physical handicap which hinders their ability to hold and turn the pages of a book. Since the user no longer needs the assistance of an attendant to hold and turn the pages of a book, the user will become more independent. This device also allows the attendant to help others more effectively. This device is designed to be used with various switches so that it can help any individual who has limited arm and hand coordination.

TECHNICAL DESCRIPTION

This project was to make improvements on the page turner that was supplied by Gorman School. The improvements that were addressed in this project were: 1) to stabilize books of various sizes better than devices on the market, 2) to set the device at various angles rather than two different angles, 3) to reduce the AC voltage out to the user switch, 4) to make the device switch independent, and 5) to make the device turn the pages of a book reliably.

I used a tracking system in which four stabilizers and a bottom book brace can easily glide so they can be set for various sized books. A test was run to determine if the color of the page turner was reasonable. To find this out, I talked with Dr. Caccioppo, a Human Factors professor. He checked the reflectivity of the surface and found that it was 94 - 108 lux. This, he said, was a reasonable range of reflectivity. The noise level of the page turner seemed to be a problem. Again, I went to talk with Dr. Caccioppo. First, he measured the noise level of a relatively quiet environment and found the measurement to be 55 dB_A. Then he measured the noise level with the page turner on. The dB level only increased to 58 dB_A. Therefore, the problem is the frequency of the "hum" and the noise level. The frequency is 60 Hz which is due to the normal hystersis of the motor. Therefore, no improvement on the noise level of the page turner was needed. To make the device switch independent, a jack that can be used with various switches (which Gorman School uses) was installed in the device.

Each book was tested with the device to see if it could accomplish the following specifications. 1) The device had to turn pages reliably, one page at a time, when the switch was activated. 2) The device had to hold the books so that the pages did not flip on their own when the book was set on the slant board at various angles. 3) The device had to work with several switches that had 1/8 inch plugs. 4) The noise level of the device had to be minimal. 5) The page turner had to be operated by ordinary house current which was grounded. The result of the testing was that the device was able to meet all of the specifications.

The switch controlled page turner cost six hundred dollars ($600) to improve. This device can be connected with any switches currently in use at the Gorman School. We would like to thank the National Science Foundation for partially supporting this design project.

"Communication Board"

Designer: Kelly Doyle
Handicapped Coordinator: Bonnie Wilson, Fairacre School
Supervising Professor: Dr. Chandler Phillips
Department of Biomedical and Human Factors Engineering
Wright State University
Dayton, OH 45435

INTRODUCTION

This project involved the custom design and construction of a communication board for a student at Fairacre School. The board had to meet several specifications. It was to be incorporated with or easily attached to the student's wheelchair tray so as not to limit working space or obstruct vision. The board contains a buzzer and a dial which are each activated by the student's elbow. With the activation of the switch, the dial is turned in a circular fashion pointing at various pictures of items the subject may want to choose. For example, the picture may be of a toy the subject likes, food, clothes, a diaper, or people. The buzzer is activated in some manner by the subject indicating that she needs help or wants to communicate.

SUMMARY OF IMPACT

The communication board was designed for a twelve year old girl who attends Fairacre School. The student is diagnosed with cerebral palsy and is nonverbal and nonambulatory. However, the student is able to move her arms to activate a switch through pressure applied by the elbow. Presently, when a choice is given to the student, it is automatically decided by another person since the subject cannot communicate with others. The board will enable the student to communicate much more quickly and efficiently. With this improved communication ability, the student will be able to control choices which are made for her. As a result, her educational level will vastly increase.

TECHNICAL DESCRIPTION

There were several problems that had to be solved since the board was custom made for the subject taking into account all of her physical disabilities. The dial had to rotate slowly and contain an arrow that is easily seen. This enables better tracking of the dial and takes into consideration the subjects reaction time. The elbow switch had to be designed and adjusted so that it is easily accessible and meets the muscular characteristics of the subject. A way to activate the buzzer had to be found. Finally, the manner in which the board is attached to or incorporated with the wheelchair tray had to be determined.

There are several communication systems that exist on the market. However, none of them can be used directly by the subject without modification due to her specific handicap. There are existing devices that relate to certain parts of my design. I decided to purchase these existing devices and modify them for use in the project. After these devices were purchased, they had to be mounted to the wheelchair tray. It was determined to attach two elbow switches to the tray with L brackets that can be moved in three planes. The Chime Alarm and Dial Scan battery box were mounted underneath the tray with a very strong Velcro called Dual Lock. The face of the Dial Scan is mounted in a slot of a block of wood which is attached with Dual Lock to the tray.

The entire device was made easily transportable by cutting a hole in the tray so that the face of the Dial Scan will lay flat on the tray when removed from the block of wood. Two clear polycarbonate coverings were hinged to the sides of the tray. When the Dial Scan is not in use, the coverings are closed and a flat useful surface is available to the subject.

Once the method for mounting the devices and making the project easily transportable was determined, the project was constructed at Hamilton Health Aid Services.

The cost of this communication board was one thousand two hundred fifty dollars ($1,250). We wish to thank the National Science Foundation for partially supporting this design project.

"Youth Lift Chair"

Designer: Jinous Vafaie
Handicapped Coordinator: Peter Lanasa, Gorman Public School
Supervising Professor: Dr. David Reynolds
Department of Biomedical and Human Factors Engineering
Wright State University
Dayton, OH 45435

INTRODUCTION

The objective of this design is a youth seat which aids the student in standing up so that minimal motor skill or energy is expended. The method of solving the problem involves a lift chair which operates with the use of a very slow speed (geared down) motor under the chair that is connected to a shaft (under the seat). The seat is hinged in the front so that with the use of the motor it can raise to the angle that is desired. Activation by an overlarge switch will slowly move the seat up or down to the desired position.

SUMMARY OF IMPACT

The student has Duchenne's muscular dystrophy, which is a progressive muscular disorder that can make transitional movements (i.e., coming from sitting to standing) difficult and fatiguing. Duchenne's muscular dystrophy is characterized by weakness of the affected muscles. The youth lift chair is designed so that the student will need less strength to change positions from sitting to standing. This will make changing positions easier for the student and will allow him to save some energy for other activities.

TECHNICAL DESCRIPTION

To solve this problem, I have designed a youth seat that aids the patient in standing up so that minimal motor skill or energy is expended. The method of solving the problem involved a lift chair which operates with the use of a very slow speed (geared down) motor under the chair that is connected to a shaft (under the seat).

A regular chair was bought and a wooden base was placed under the seat. The bolt used in hinging the seat was placed under the seat such that the subject would not be pinched. A three way switch was used (placed on one of the arm rests of the chair) so that the subject could go from sitting to standing and also vice versa. The shaft had an 8" rise; and the shaft and motor had to be placed no more than 8" from the hinge point.

The motor used was type U62 Fasco Industries, Inc. It had the following specifications: volt: 115; Hz: 60; amp: 2.7; 3200 rpm. A capacitor (PSU3630) was also used and set up as specified on the motor.

The chair is now being painted at the machine shop and is ready to be given to the student at Gorman School.

The youth lift chair cost six hundred dollars ($600) to build. We wish to thank the National Science Foundation for partially supporting this project.

"Supportive Floor Seating"

Designer: Vera Osidach
Handicapped Coordinator: Peter Lanasa, Gorman Public School
Supervising Professor: Dr. Chandler Phillips
Department of Biomedical and Human Factors Engineering
Wright State University
Dayton, OH 45435

INTRODUCTION

This supportive floor seating unit was designed to meet the needs of a child who could not sit comfortably upon the floor. The child was observed at Gorman School with and without the aid of an assistant. Without an individual behind for support, the child would roll backwards onto his back. It was decided that a small, lightweight chair could be designed to assist the child. The chair would provide back support and also allow for variation in height from the floor, thus easing pain in tight leg muscles. The presence of this unit would allow the assistant more time to provide for other children and thereby increase productivity and efficiency. The unit would be lightweight enough to be portable, yet heavy enough to provide stability.

SUMMARY OF IMPACT

This project was individualized for one particular child who demonstrated a need for assistance in everyday school activities. The child was unable to support himself when seated upon the floor during playtime. An assistant was constantly required to sit behind him and provide back support. In addition, the child could not remain seated on the floor for any amount of time due to the occurrence of pain in his spastic hamstrings. Furthermore, when exited, the student flexed his leg muscles resulting in a force being exerted on the floor. Due to this extra energy, the seating unit would be designed to avoid any possible tipping when the child became excited. Ultimately, the seating unit would enable the child to participate normally during playtime. He would be able to reach out and move about, but mostly to remain seated comfortably on the floor.

TECHNICAL DESCRIPTION

TECHNICAL REPORT: The problem of the child's inability to sit comfortably upon the floor had to be solved. It was proposed that the device meet the following requirements: 1) comfort, 2) ease of adjustment, 3) back support (variation in tilt angle), 4) variation in height from floor, 5) stability, and 6) portability. Some features which needed to be considered while designing the unit were: a) the type of cushions needed; b) the type of head support required; and c) the type of back support desired.

Several ideas were developed, including an inflatable unit and a motorized unit, but the most cost-efficient device was determined to be constructed of wood with a manual adjustment device. Several manual adjustment devices were considered utilizing various materials, such as metals, plastics, and leathers. However, the most compact and easiest method was the addition of separate units when height adjustment was desired. The final design schematic consisted of a wooden body, a metal back adjustment mechanism, a safety belt, and one inch of hospital type foam padding on the backrest and seat.

To avoid any possible tipping of the unit, it was determined that the base should be angled so that it would be improbable that any movement by the child would provide a moment about any edge of the chair. Calculations were done for the chair without having an angled base and then on the chair with an angled base. The angle of the base was determined with a safety margin of three. It was also determined that the angle of the base along the back of the unit should be the same as the angles on the other sides to avoid tipping when the backrest is completely reclined.

After the wooden units were made but before they were padded or painted, the metal adjustment mechanism was attached; and the unit was taken to Gorman School for an initial trial with the child. The seat fit him quite well and promised minimal adjustments to the final product at a later date. It was at this time that the child stated that he wanted his seat painted green. He specifically chose a particularly attractive shade of emerald green and, therefore, the unit was painted green!

After all components of the product were completed (padding, painting, chrome-plating of the metal parts, attachment of the seatbelt), a final trial was done. The final trial went quite well; so well, in fact that no additional adjustments were required. The student was very happy with his seat and especially the color.

The total cost of the supportive floor seating unit was nine hundred fifty dollars ($950). We wish to thank the National Science Foundation for partially supporting this project.

"Walker Communication Table"

Designer: Dave Cartmell
Handicapped Coordinator: Peter Lanasa, Gorman Public School
Supervising Professor: Dr. Chandler Phillips
Department of Biomedical and Human Factors Engineering
Wright State University
Dayton, OH 45435

INTRODUCTION

This project is a device that, when mounted to a walker, will allow the versatility of making a speech communicator possible. The assistive communication device was provided by Gorman School. The project culminated in the design of a walker communication table. This table is a version of an assisted walker with a table attached which supports the communication device. Thus, the walker communication table allows for greater mobility for a speech impaired student.

SUMMARY OF IMPACT

This project was designed for a student at Gorman School who was unable to communicate through speech. He used an assistive speech communicator that improved his relations with others. The student also required the aid of a walker. However, he was unable to use the speech communicator and the walker at the same time. The walker communication table allows him to communicate when he is mobile. This greatly increases his opportunities to communicate with other students or with the staff at his school.

TECHNICAL DESCRIPTION

This project is a device that, when mounted to a walker, will allow the versatility of making a speech communicator portable. Development of the project was initiated by visiting Gorman School where the assisting walker device was kept. A teacher demonstrated the mechanics of the walker and the communication aid called the "Wolf". The Wolf is a device that allows a speech impaired individual to communicate via a touch sensitive keypad and synthesized voice command.

The goals of the design were to assure static equilibrium and maintain all characteristics of the original walker.. These include light weight, ease of entry, and movability. With these specifications, a design was to be conceived and built to apply to the walker. After reviewing the known information and specifications, drawings and engineering methods were developed to apply to the project design. All ideas and concerns were discussed with Dr. Phillips for his input and approval.

The point of application of the device was the first decision that had to be made. It was chosen that the horizontal bar on the front of the walker would be used. After making this decision, it was necessary to design a component that would attach to this bar and provide a foundation for the rest of the design to be built upon. This component, termed "tube clamp," was developed by making rough sketches and then submitting 3-view, dimensioned drawings in the machine shop.

The next component to be designed was a horizontal tube that would attach to the communication table, allow for height adjustability, and permit the table to swing away from the walker entrance. This was also performed in the same manner as the tube clamp. The communication table and the clamps that attach it to the tube were easily designed after the above components were completed.

This project required seven hundred dollars ($700) to complete. We wish to thank the National Science Foundation for partially supporting this project.

"Wheelchair Lap Board"

Designer: Amar Hamad
Handicapped Coordinator: Peter Lanasa, Gorman Public School
Supervising Professor: Dr. Chandler Phillips
Department of Biomedical and Human Factors Engineering
Wright State University
Dayton, OH 45435

INTRODUCTION

A student at Gorman School likes to use his wheelchair independently with almost no help from others. This student needed a lap board to be installed on the wheelchair to carry a small communication device called "WOLF". The wheelchair lap board is a new lap board which holds the communication device and allows the student to move the wheelchair by himself. The new lapboard does not have to be removed to move the wheelchair. Also, the new design is adjustable in any direction to make it easier to use and more efficient.

SUMMARY OF IMPACT

Currently, the student has an oversized lap board which makes it difficult for him to use the wheelchair properly. If the student wants to move the wheelchair by himself, he must remove the lap board. Doing so also requires that the communication device be removed, and the student cannot communicate with others. So, it is either to move the wheelchair and not communicate or to communicate and not move the wheelchair. The new lap board enables the student to be more functionally independent since he can move and communicate at the same time. Since he is able to do more without the aid of an attendant, the attendants can focus more time on other students.

TECHNICAL DESCRIPTION:

Quarter (1): I chose one of the problems presented by Dr. Phillips to be my senior design project. I read the problem carefully and I started to think how am I going to approach that problem. Then I got an idea about how to design this project and the next step was to put that design on paper and try to visualize it. I also estimated what the cost would be to build it and how much time it should take to finish it completely. Then a proposal was written to get it approved by the Bio-Medical Engineering Faculty with all drawings and details I got at that time.

Quarter (2): The project got approved by the Bio-Medical Engineering Faculty. Then I had to make some changes on the design, like what shape and kind of pipes are best to use. These changes were made to lower the cost of implementing the design by ordering standard parts and avoiding any special orders. Then an Eleven Hundred form was filled out and signed by Dr. Phillips to order the parts needed through the Instrument Shop of the University.

Quarter (3): The parts were in stock by the beginning of the quarter and ready for work. We first took some measurements on the wheelchair to start building up the design in the Instrument Shop. After the design was almost completed, we did the first testing on the wheelchair. A problem came out, where the design should be hooked to the wheelchair, due to a small inaccurate measurement. So we had to go back and correct it, and it was ready by the next week. A second testing was done to see how the modifications were going to work. Fortunately, it worked fine, and then we had to take it back for final touches and polishing and painting it with the same color of the wheelchair. The last thing to do was to take some pictures for the records of the Instrument Shop, Dr. Phillips' final report, and some slides for the presentation.

The cost of the wheelchair lap board was seven hundred dollars ($700). We wish to thank the National Science Foundation for partially supporting this project.

"Hydrocephalic Head Support Device"

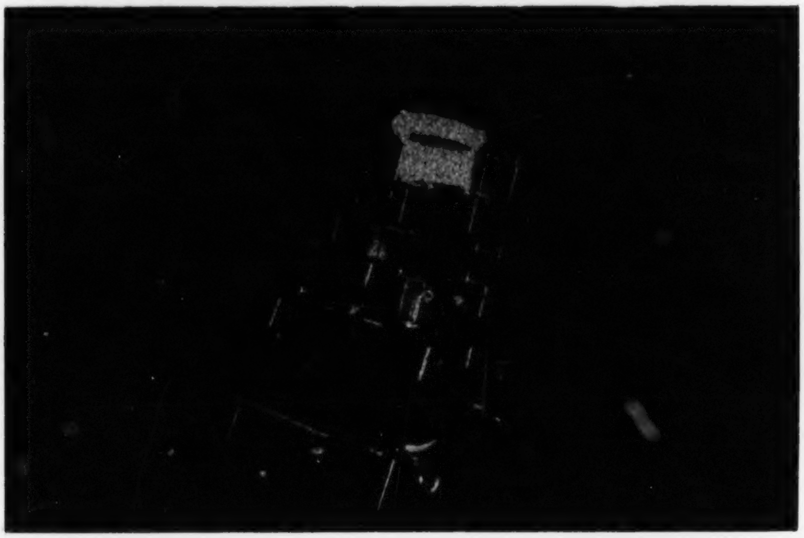
Designer: M. Al Matri
Handicapped Coordinator: Bonnie Wilson, Fairacre School
Supervising Professor: Dr. Chandler Phillips
Department of Biomedical and Human Factors Engineering
Wright State University
Dayton, OH 45435

INTRODUCTION

This project was designed for a student with hydrocephalus and who needed head support. There are currently two different kinds of devices commercially available for hydrocephalus patients. One is a pillow type device that is placed under the patient's chin and around his/her neck. This device was found to cause difficulty in eating and breathing for this particular student. The student was using a "Molholland Positioning System" (MPS) which is designed to control the development of orthopedic deformities and enhance distal control. The MPS is designed with a head support which supports the head and upper body at 120 degrees from vertical. We wished to design a headrest to hold the head/upper body at 90 degrees from vertical.

SUMMARY OF IMPACT

This device was designed for a student who has hydrocephalus and sits in a wheelchair with his head supported by a halo/headrest device attached to the wheelchair. The halo/headrest is not well fitted to the student and thus required a redesign to provide a better fit. The new design enabled the student to be more comfortable and to be seated in a clinically designated position. Providing greater comfort will allow the student to interact more in the activities of his home and school.



TECHNICAL DESCRIPTION

Our project had the following designs:

(1) To prevent the irritation, we used one layer of foam, another layer of padding on the top of it, then both covered with a third layer of 'canvas' cloth, and all covered with a soft 'shearking fur' which will protect the specification of this device, as shown in figure (2).

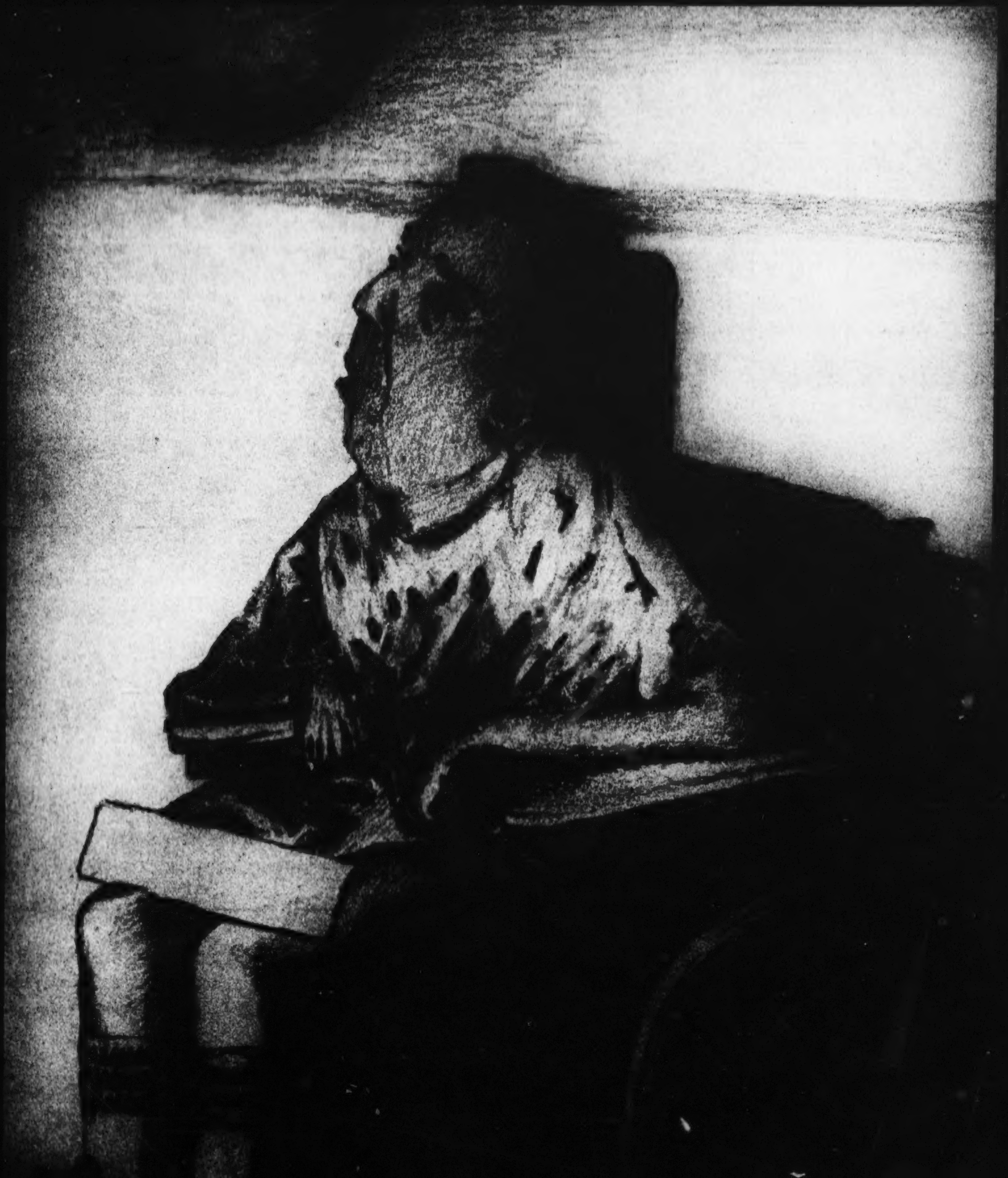
(2) The halo has a knob-lock, which makes it impossible to unlock without a supervisor.

(3) Using the same kind of batting for the halo system, and changing its position from the one shown in the picture to be parallel with his/her forehead, will prevent the patient's head from sliding through the halo, and a new design has been added to the halo, where the halo will be flexible for enlargement to meet the patient's growth and development.

(4) Widening the upper neckrest's pad and placing it at the right angle (parallel to the back growth of his/her head) will minimize the irritation, design it to be adjustable several directions in order to maintain the long term support, and to insure the comfort of the patient.

(5) Widening the lower neckrest's pad, using the same batting, and the same adjustable ranges, will increase the stability of our device.

The cost of the redesign was seven hundred dollars ($700). We wish to thank the National Science Foundation for partially supporting this project.



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